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SPACE LIFE SCIENCES

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National Space Biomedical Research Institute
Education and Public Outreach

Bone Quest – A Space-Based Science and Health Education Unit

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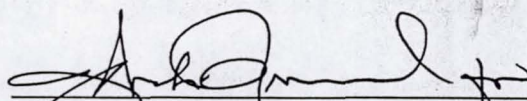

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ABSTRACT

This proposal addresses the need for effective and innovative science and health education materials that focus on space bone biology and its implications for bone health on Earth. The focus of these materials, bone biology and health, will increase science knowledge as well as health awareness. Current investigations of the bone loss observed after long-duration space missions provide a link between studies of bone health in space, and studies of osteoporosis, a disease characterized by bone loss and progressive skeletal weakness. **The overall goal of this project is to design and develop web-based and print-based materials for high school science students, that will address the following: a) knowledge of normal bone biology and bone biology in a microgravity environment; b) knowledge of osteoporosis; c) knowledge of treatment modalities for space- and Earth-based bone loss; and d) bone-related nutrition knowledge and behavior.**

To this end, we propose to design and develop a *Bone Biology Tutorial* which will instruct students about normal bone biology, bone biology in a microgravity environment, osteoporosis - its definition, detection, risk factors, and prevention, treatment modalities for space- and Earth-based bone loss, and the importance of nutrition in bone health. Particular emphasis will be placed on current trends in adolescent nutrition, and their relationships to bone health.

Additionally, we propose to design and develop two interactive nutrition/health education activities that will allow students to apply the information provided in the *Bone Biology Tutorial*. In the first, students will apply constructs provided in the *Bone Biology Tutorial* to design "Bone Health Plans" for space travelers. In the second activity,

students will evaluate their own bone health knowledge, using both exercise and dietary assessment tools.

This project draws on the expertise of NASA nutritional scientists, NSBRI experts in the area of calcium and bone metabolism, and University of Houston collaborators with expertise in the areas of health education, evaluation and instructional technology. The intended outcomes of the materials produced include an increase in student knowledge of bone biology and health in microgravity and on Earth, and an increase in positive attitudes regarding the importance of diet and exercise practices for prevention of bone loss. In addition, knowledge and attitudinal changes will be translated into behavior change (as measured through log analysis of their practices). Pre- and posttests will be administered to evaluate changes in student knowledge, attitudes and behaviors.

The evaluation plan will also include a field test of the Instructional Technology components with focus groups of students and educators. A preliminary needs assessment will be conducted to determine technology preferences, access and design preferences of students and teachers in both health and science education prior to the development of the interactive multimedia activities. Process and context-specific evaluation will be used during implementation. Teacher interviews and a written questionnaire will be used to ascertain teacher satisfaction with use of the unit and recommended changes during the project pilot. Reliability and validity of the evaluation instruments will be determined, as well as content validity of the planned instructional units. **This proposal highlights current NASA and NSBRI research activities in space biology, and presents a novel application of the microgravity environment for the study of human biology and health.**

BUDGET

	Year 1	Year 2	Year 3
<u>Personnel (% effort)</u>			
Smith, SM, PI (10%)	\$0	\$0	\$0
Davis-Street, JE, Co-I (50%)	\$22,000	\$22,880	\$23,795
Fringe	\$8,800	\$9,152	\$9,518
Indirect costs	\$30,800	\$32,032	\$33,313
Abrams, SA, Co-I (5%)	\$6,000	\$6,240	\$6,490
Fringe	\$1,500	\$1,560	\$1,622
Indirect costs	\$4,650	\$4,836	\$5,029
Direct Sub-total:	\$38,300	\$39,832	\$41,425
Indirect Sub-total:	\$35,450	\$36,868	\$38,343
<u>Collaborators/Sub-Contracts</u>			
Gingiss, P; Collaborator	\$5,000	\$5,200	\$5,408
McNeill, S; Collaborator	\$5,000	\$5,200	\$5,408
TBD; Computer Programmer	\$7,500	\$15,000	\$15,000
Sub-total:	\$17,500	\$25,400	\$25,816
<u>Supplies</u>			
Software (maintenance/upgrades)	\$2,500	\$2,600	\$2,704
Printing/reproduction costs	\$7,500	\$15,000	\$20,000
General/Office supplies	\$1,500	\$1,560	\$1,622
Computer Support	\$1,500	\$1,560	\$1,622
Sub-total:	\$13,000	\$20,720	\$25,949
<u>Travel</u>			
Scientific meetings	\$2,000	\$2,080	\$2,163
NSBRI meetings	\$3,000	\$3,120	\$3,245
Sub-total:	\$5,000	\$5,200	\$5,408
TOTAL DIRECT COSTS	\$73,800	\$91,152	\$98,598
TOTAL INDIRECT COSTS	\$35,450	\$36,868	\$38,343
ANNUAL TOTAL COSTS	\$109,250	\$128,020	\$136,941

Budget Justification

LABOR

The PI (SM Smith) is a NASA employee, and thus salary costs are not included. When information is available on full-cost accounting, budgets will need to be re-cast.

Labor costs are also included for the two Co-Investigators, Ms. Davis-Street at JSC, and Dr. Abrams at the Baylor College of Medicine.

CONSULTANT COSTS

Costs are included for Collaborators Drs. Gingiss and McNeil. Dr. Gingiss will assist in the development, field-testing, implementation and evaluation of the project. Dr. McNeil will assist in the development and evaluation of instructional technology activities. Costs are also included for a to be named computer programmer to develop the interactive, web-based multimedia *Building Better Bones* series of activities.

SUPPLIES

SOFTWARE products are required for the design and development of the *Bone Biology Tutorial*.

PRINTING AND REPRODUCTION costs are based on estimates of needs for distribution and dissemination of the print-based components and evaluation materials.

OFFICE SUPPLIES include paper, writing materials, and binders.

TRAVEL

Travel is included for support of travel to scientific and education meetings. Travel is also included for support of expenses to attend NSBRI meetings, as described in detail in the Research Announcement.

INDIRECT COSTS

Indirect costs for JSC are based on the approximate 100% burden on labor for NASA contracts. **Materials, travel and all other listed NASA expenses do not have indirect costs associated with them.** Indirect costs for Dr. Abrams' costs are 64%, based on Baylor College of Medicine rates.

Increases for Years 2 and 3 are assumed at 4%.

NARRATIVE

BACKGROUND

Nutrition is implicated in the etiology of several chronic diseases, and is well recognized as a determinant of health (Lee and Estes, 2000). Health educators are constantly challenged to develop meaningful educational strategies, which elicit behavior change in the population of interest. The emergence of the internet as one of the dominant sources of information, as well as the advances in computer technology of the past decade, have tremendous potential for the dissemination of sound educational materials.

Web-based instruction has been used successfully in a variety of education settings (Barron et al., 1996). We propose to design a web-based science and health curriculum that focuses on bone biology and health during space flight and on Earth. Bone loss represents one of the most significant challenges to long-duration space flight (Smith et al., 1999; Holick, 2000). Understanding the mechanisms of bone loss during space flight, and the development of treatments to limit this loss, will have major implications for the treatment of osteoporosis. Furthermore, this focus on space-induced bone loss in conjunction with the bone disease, osteoporosis, provides an excellent example of the potential space benefits for human health. Osteoporosis represents a current and significant health issue for the aging American population. Health education during childhood and early adulthood can have a significant impact in modifying life-style risk factors associated with osteoporosis (Lytle et al., 2000). This curriculum will address life-style choices, which increase risk of bone diseases on Earth. Space flight thus represents a unique 'laboratory' for the investigation of this and other physiological systems.

This proposal seeks to extend the scientific literacy of high school students in the areas of bone biology and bone health. We intend to provide a general review of these areas as they relate to long duration space travelers and the general population, and incorporate the salient concepts in the development of a novel science and health education unit for high school students. The curriculum described herein also uses the space flight model and current trends in adolescent dietary behavior to provide a practical application of bone biology, nutrition and health.

Fundamentals of Bone Biology

Bone consists of 4 different types of cell types – osteoblasts, osteoclasts, bone lining cells, and osteocytes (Marks and Hermey, 1996). Osteoblasts are responsible for the production of bone matrix (i.e. bone forming cells). Osteocytes are the mature osteoblasts within the bone matrix, and are responsible for the maintenance of the bone mineral (Buckwalter et al., 1995). The bone lining cells are inactive cells that cover the bone surface, while the osteoclasts are large multinucleated cells responsible for bone resorption, or breakdown (Marks and Hermey, 1996). Bone remodeling represents the dynamic processes of bone formation and breakdown. Understanding changes in bone remodeling on Earth and in space has relied heavily on the ability to monitor markers of bone turnover, as well as the physical measurement of bone mass. Bone turnover

markers include markers of formation, (e.g. osteocalcin and alkaline phosphatase) and markers of resorption, (e.g. collagen breakdown products, calcium, and hydroxyproline).

Bone Loss During Space Flight

Bone loss represents one of the greatest challenges for future space travel (Smith et al., 1999; Holick et al., 2000). Our studies of Mir astronauts and cosmonauts have utilized state-of-the-art methods to monitor the movement of calcium in the body (Figure 1). These studies have demonstrated that bone resorption is increased during space flight, while bone formation is either decreased or unchanged (Smith et al., 1999; Smith et al., 2000). The net result on bone turnover is a loss in bone mineral that appears to vary in anatomical location, as well as among individual crewmembers (Smith et al., 1999; Shackelford et al., 1999). Specifically, bone loss is greatest in the weight-bearing bones (e.g. hip, calcaneus).

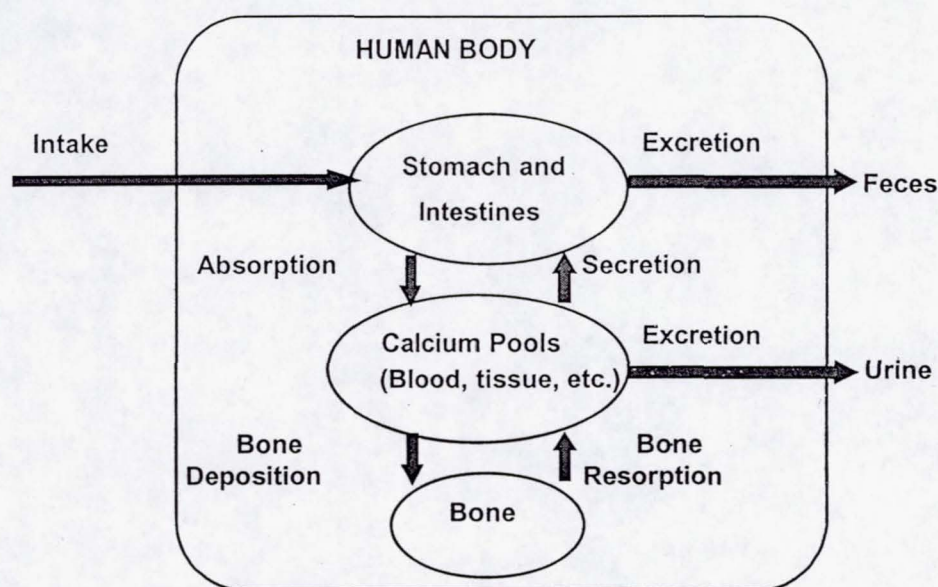


Figure 1. Calcium Movement in the Body

Additional information about bone loss during space flight is provided by measurement of biochemical markers in blood and urine. Serum measurements of these markers (e.g. parathyroid hormone, the vitamin D metabolites, osteocalcin and calcitonin) provide information regarding potential mechanisms of bone loss during space flight. Urinary markers (e.g. collagen crosslinks, hydroxyproline, and calcium) also provide complementary data about bone and calcium homeostasis during and after space flight. The results from these analyses have supported those from the kinetics studies, and demonstrate that skeletal unloading during space flight results in increased bone resorption with either unchanged or decreased bone formation.

Several approaches have been taken for investigating potential countermeasures for the bone loss of space flight. These have included exercise protocols, nutritional and pharmacological interventions. Existing exercise protocols have focused on aerobic activities. These protocols, however, have been unable to maintain muscle and bone mass during space flight (Schneider and McDonald, 1984; LeBlanc et al., 1996).

Preliminary data from current ground-based assessments investigating the use of resistive exercise regimens, show promise for use on-orbit (Shackelford et al., unpublished observations). Nutritional considerations for bone health have focused primarily on calcium and vitamin D. While the space food systems can provide adequate amounts of calcium, the current food system is unable to provide adequate vitamin D. In addition, vitamin D production from ultraviolet radiation within the skin is limited, as the spacecraft are shielded to protect crewmembers from harmful radiation. Additional nutrition interactions important for bone health include adequate vitamin K, and moderate amounts of protein and sodium. Excessive amounts of protein and sodium, have been shown to increase mineral loss from bone in Earth-based models, and these issues remain of concern during space flight. A role for Vitamin K nutrition in bone health has been suggested through the role of the vitamin in osteocalcin metabolism (Vermeer, 1997). However, there is limited information on the efficacy of vitamin K supplementation on reducing either flight-induced or normal/disease-induced bone loss. Nevertheless, the space program will need to understand the effects of space on bone health and nutrition before we can undertake exploration missions. This information will be very helpful for our understanding of bone diseases here on Earth. We have completed studies of bone health as part of current nutritional assessment protocols, and as the main focus of research studies on Space Station Mir. Additionally, studies are currently in development for flights on Shuttle and the International Space Station.

Bone Disease on Earth

Osteoporosis is one of the major bone diseases here on Earth. This disorder is typically characterized by asymptomatic bone loss and progressive weakness of the skeleton. Osteoporosis is frequently present without overt clinical signs and is often diagnosed subsequent to fractures caused by minimal trauma (Sigman-Grant and Kris-Etherton, 1999). Typical fracture sites are the hip, wrist or vertebrae. This disorder affects approximately 24 million Americans, and is the major cause of the approximately 1.3 million bone fractures that occur annually in older adults (Sigman-Grant and Kris-Etherton, 1999). Osteoporosis results in tremendous increases in medical costs for the elderly, with hip fractures accounting for about \$8 billion annually in short-term medical costs.

Because of the variety of osteoporotic conditions, osteoporosis is often classified in subtypes. Primary osteoporosis is further subdivided into Type I Osteoporosis resulting from the decline in estrogen production in postmenopausal women. Type II Osteoporosis, or senile osteoporosis is common in both men and women, but occurs at an earlier age in women. Due to the increasing aging of the U.S. population, it is estimated that the rate of hip fractures due to osteoporosis will increase almost threefold by the year 2040 (Schneider et al., 1995).

Bone health appears to be a function of nutrition (primarily calcium), hormones (primarily estrogen), and lifestyle (primarily resistive weight-bearing exercise) (Anderson et al., 1999). Inadequate nutrition – including poor intakes of calcium and/or vitamin D, high protein-low calcium diets, and poor caloric intakes have all been implicated in the mechanisms of bone loss. Other risk factors for osteoporosis include increasing age, female gender, ethnicity (Asian and Caucasian women are at higher risk), bone

structure and body weight (smaller boned and thin women are at higher risk), and menopause/menstrual history (normal or early menopause increases risk).

Heaney et al. (1998) have proposed a role for nutrition in protecting against osteoporosis throughout the life span. During childhood the emphasis should be on adequate nutrition during growth to achieve the full potential for bone growth and offset daily losses; during adulthood the role of nutrition is to preserve existing bone mass and facilitate recovery from injury etc.; and finally in the elderly, nutrition has a role in the susceptibility to fragility and recovery from fractures. Nevertheless, once osteoporosis occurs, there is little evidence of efficacious treatments which truly reverse the condition. Medical and nutritional interventions have focused on retarding the disease process and improving the quality of life. Nutrition recommendations in the treatment phase include adequate intakes of calcium, vitamins D and K, and moderate/limited intakes of factors known to negatively impact calcium, including protein, alcohol, and sodium. The majority of pharmacological treatments for osteoporosis focus on the retardation of bone breakdown. These include calcium, estrogen, calcitonin, and more recently, the bisphosphonates. Fluoride and parathyroid hormone treatment have been implicated in increasing bone mass, and have also been used. Other experimental drugs, including Insulin-like Growth Factor I and Zeolite A are also being examined for their ability to increase bone formation (Drezner, 1995).

Assessment of bone mass and bone mineral content can be accurately and reliably measured using a variety of techniques (Blake and Fogelman, 1996), including bone histomorphometry, radiographic absorptiometry, single-photon and single-energy X-radiographic absorptiometry, dual photon and dual-energy s-radiographic absorptiometry, and quantitative computed tomography. However, these techniques provide only a static picture of the bone and provide no information on the dynamic processes of formation and resorption. Bone markers in urine and blood are typically used to monitor therapeutic regimens for the treatment of osteoporosis (Garner and Delmas, 1996).

Nutrition and Adolescent Bone Health

Promotion of bone health and prevention of bone disease should begin early during the prepubertal years and continued throughout life. Data supporting the role of adequate nutrition, specifically calcium intakes, as well as physical activity in facilitating optimal bone mass accretion by early adulthood have been provided by several studies (Weaver, 2000). The greatest amount of calcium incorporated into the skeleton occurs during the peripubertal period (Anderson, 1995). Approximately 50% of total bone mineral content is deposited between ages 9-18 in females, and 10-20 in males. Prepubertal calcium consumption may thus be the most critical period in bone growth and development (Anderson, 1995). Although skeletal effects of adverse behaviors, e.g. smoking, alcohol intake, excessive weight loss, and amenorrhea secondary to excessive exercise, have yet to be identified (Compston et al., 1992), the importance of calcium nutrition in bone health throughout the life-span is well accepted in the scientific literature.

Calcium and phosphorous intakes have traditionally been expressed in conjunction with each other, due to their coexistence in dairy foods, and their common metabolism and function. Optimal dietary ratios of Ca:P range from 1:1 to 1:2. While the majority of

calcium in the U.S. diet is provided by dairy foods, fortified breads and baked goods, dark leafy green vegetables, and fortified juices, phosphorus is widely available in all food groups (Anderson and Garner, 1995). Additionally, phosphorus is obtained from cola type beverages and food additives. The increasing consumption of carbonated beverages amongst American adolescents is of particular concern with regard to bone health. Studies of adolescents demonstrate an increase in the consumption of carbonated beverages, while intakes of milk are decreasing (Cavadini et al., 2000; Jacobson, 1998; Lytle et al., 2000). Associations between cola beverage consumption and fracture risk have been noted amongst adolescent girls (Wyshak, 2000) but not boys (Wyshak and Frisch, 1994). Carbonated beverages containing phosphoric acid have also been linked to hypocalcemia in a study of 57 Mexican children (Mazariegos-Ramos et al., 1995). Fleming and Heimbach (1994) have also reported low calcium intakes among girls aged 12-19. Trends towards increasing consumption of carbonated beverages may have significant implications for public health policy for bone health during childhood.

Theoretical Foundations

While younger children appear to be dependent on adults for determining their eating behavior, adolescents are more likely to make independent choices (Noller, 1994). Further, theoretical foundations for understanding and predicting adolescent behavior are limited (Baranowski et al., 1999). McKenzie and Smeltzer (1997) in their review of existing theories and models used in health promotion, recommend that several theories be combined. We have elected to combine several aspects of the transtheoretical model and the social cognitive model in the health education portion of this project. The *transtheoretical model* suggests that individuals exist at different stages of change, moving from *precontemplation* (not intending change), to *contemplation* (thinking about change), to *preparation* (planning change), to *action* (making change) and into *maintenance* (sustaining change) (Prochaska et al., 1994). In health education, the social cognitive model focuses on the construct of self-efficacy, and describes learning as an interaction between the environment, cognitive processes, and behavior (Parcel, 1983). In order to promote healthy eating habits as they relate to bone health, individuals need to be instructed on what those behaviors are, and how to perform them. This construct, termed *behavioral capability*, will be provided as part of the *Bone Biology Tutorial*. Secondly the construct of *expectancies*, the value placed on building healthy bones will be incorporated, and will be the mechanisms through which attitudinal and behavior changes are planned to be affected. Information supporting *outcome expectations*, the belief that the outcome (healthy bones), is personally beneficial, is included in the tutorial. The curriculum will focus on education and awareness building through the tutorial, and include opportunities for personal assessment, knowledge and skill building. Interactive activities will be designed to moved students along the stages of change.

The computer-based instruction will use Gagne's events of instruction (Gagne et al., 1988) in its design protocol in order to encourage learning: gaining attention, activating motivation, stimulating recall of prerequisite material, presenting stimulus material, providing learner guidance, eliciting performance, providing feedback, assessing performance, and promoting retention and transfer. These events will be

incorporated in the bone Biology Tutorial. Moreover the *Building Better Bones* Series offers an excellent opportunity to demonstrate transfer of concepts provided by the tutorial.

Summary

We propose to develop *Bone Quest* – a science and health education unit that focus on parallels between space-induced bone loss and osteoporosis, as a framework for increasing knowledge about bone biology and the relationships between nutrition and bone health. The first of a series of Nutrition and Health curriculum, which tie basic biology principles with health concepts, the overall goal of this project is to design and develop effective web-based and print-based materials for high school students, that will address the following: a) knowledge of normal bone biology and bone biology in a microgravity environment; b) knowledge of osteoporosis; c) knowledge of treatment modalities for space- and Earth-based bone loss; and d) bone-related nutrition knowledge and behavior.

OBJECTIVES

The objectives of this proposal is to design, develop, and administer web-based and print-based curriculum and education materials that will facilitate the following:

- The target population (high school students) will demonstrate an increase in their knowledge about bone biology and bone health after completion of the *Bone Biology Tutorial*.
- The target population (high school students) will demonstrate improved bone health behavior as reflected by their increase in reported intakes of calcium-containing food items, and decreased consumption of carbonated beverages.
- The target population (high school students) will demonstrate an increase in positive student attitudes and behavioral intent will be demonstrated (regarding the importance of adoption of diet and exercise practices for prevention of bone loss)
- Knowledge and attitudinal changes will be translated into behavior change (as measured through log analysis of the practices of the target population (high school students)).

In order to meet these goals, the research team will:

- design and develop the web-based and print-based *Bone Biology Tutorial*.
- design and facilitate development two interactive web-based nutrition/health education units that will allow students to apply the information provided in the *Bone Biology Tutorial*.

Schedule

The detailed schedule for this project is shown below. Briefly, the print and web-based versions of the *Bone Biology Tutorial* will be designed and developed during the first year, after completion of the primary needs assessment. The design and evaluation of the tutorial evaluation materials will also be completed during the first year of funding. During the second year, we will design and develop the *Building Better Bones On Orbit* and begin design of the *Building Better Bones on Earth* unit. In the final year we will complete the design and development of *Building Better Bones on Earth*, and also perform the evaluation of Instructional Materials by Content and Educational Experts, perform the field test of the instructional Technology components, and complete the Data Assessment/Evaluation of Educational Unit.

Schedule

Year 1

- Month 1: Perform primary needs assessment
- Month 1 – 3: Design of Bone Biology Tutorial, print version
- Month 4 – 9: Design and Development of Bone Biology Tutorial, web version
- Month 10 – 12: Development and evaluation of Materials

Year 2

- Month 1 – 9: Design and Development of *Building Better Bones On Orbit*
- Month 10 – 12: Design and Development of *Building Better Bones on Earth*, Part 1

Year 3

- Month 1 – 3: Design and Development of *Building Better Bones on Earth*, Part 2
- Month 4 – 5: Evaluation of Instructional Materials (Content and Educational Experts)
- Month 6 – 9: Field Test of IT components
- Month 10 – 12: Data Assessment/Evaluation of Educational Unit

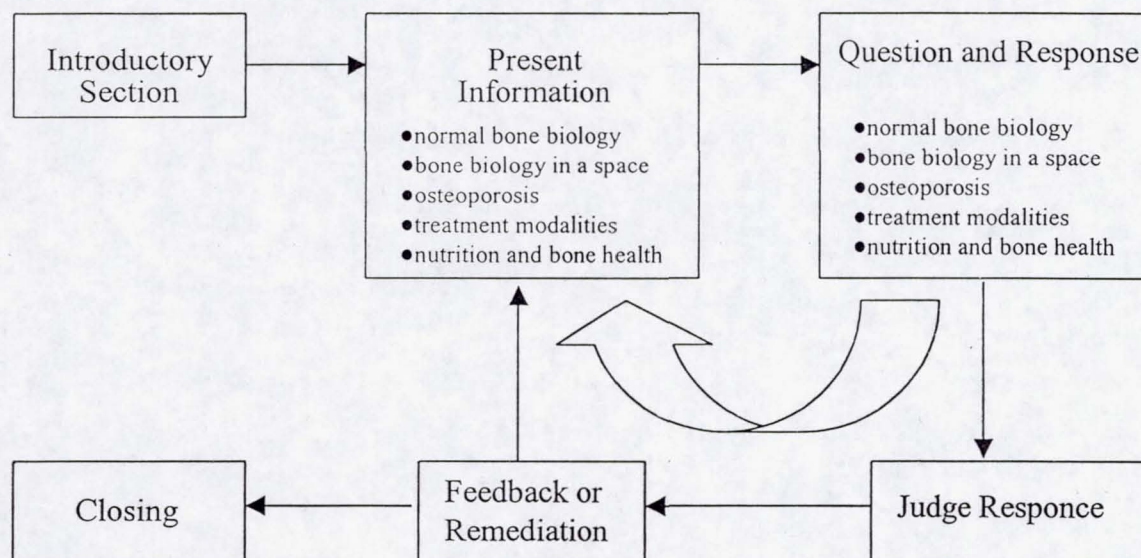
METHODOLOGY

Bone Biology Tutorial

Bone Quest includes a web-based and print-based tutorial. Topics covered by the *Bone Biology Tutorial* will include basic bone biology and bone biology in a microgravity

environment; osteoporosis - definition, detection, risk factors, and prevention; treatment modalities for space- and Earth-based bone loss; and nutrition and bone health. This tutorial provides recognized elements of the science and health curriculum (TEA, 1999), as well as addressing national content standards (NSTA, 1996). Each component of this 5-section tutorial will be available as print and computer-based instruction. Several strategies will be used to facilitate the events of instruction, including, but not limited to – multimedia with sound, graphics and text; color; problem-based instruction, revisions and content guided by the user, recall invoked by exercises, step-by-step instructions, action-oriented topics, advance organizer; multiple learning styles, hypertext maps, life-centered examples, quizzes, feedback, and summary for review. A teacher and student guide will be prepared for the print-based version of the tutorial.

The *Bone Biology Tutorial* can be used for an individual project or as a class-based activity. The basic structure and flow of the *Bone Biology Tutorial* is shown below:



Building Better Bones Series

Development of ***Bone Quest*** also includes the design of the *Building Better Bones Series*. These interactive nutrition/health activities will provide practical applications of the bone biology concepts provided by the *Bone Biology Tutorial* will include *Building Better Bones in Space* and *Building Better Bones on Earth*. In the space-based activity, students will be required to develop Bone Health Plans, which will include Exercise and Nutrition components for hypothetical space travelers. The earth-based activity will include personal evaluations of students' Bone Health knowledge, including an Exercise Inventory and evaluation of intakes of bone-related nutrients. Pre-tests and posttests will be provided.

Building Better Bones in Space. Students can select a specific space scenario and design Bone Health Plans for a crew of 3 individuals. Space Scenarios will include missions to Mars, the Moon and stays on board the ISS. Students will select the

characteristics of their crews in terms of age and gender. Bone Health Plans will include Exercise and Nutrition Components. Students will use current International Space Station menus to plan a 2-day menu for their crews. Students will receive immediate feedback on the adequacy of their Bone Health Plans. The Exercise component will be evaluated on the appropriate use of Resistive/Aerobic Exercise. The Nutrition Component will be evaluated for adequate overall nutrition, using the Food Guide Pyramid, and bone-related nutrient quality (calcium and vitamin D contents) of the 2-day menu. Scores will be awarded for each Bone Health Plan. A maximum of 100 points is possible for the Exercise Component, a maximum of 200 points is possible for the overall nutrition quality, and a maximum of 300 points is possible for bone nutrient quality. Thus a maximum of 600 points is possible for each attempt at this unit. Students must repeat this unit at least once but no more than twice. Students will be prompted to obtain a hard copy of their point summary. Feedback will be available on key concepts provided by the *Bone Biology Tutorial*.

Building Better Bones On Earth. In this unit, students will evaluate their own Bone Health knowledge. Students will conduct an Exercise Inventory, and evaluate their intakes of bone-related nutrients. Specific attention will be placed on intakes of carbonated beverages and dairy products. Numerical scores will be awarded - a maximum of 100 points is possible for the Exercise Inventory, which will be evaluated based on frequency and inclusion of both aerobic and resistance components. A maximum of 400 points is possible for their nutrient intake quality. Immediate feedback will be provided on ways to improve individual bone health and reduce osteoporosis risk in later years. A maximum of 500 points is possible for this activity. Students will complete the "Building Better Bones on Earth" twice, once with the pre-test prior to completing the *Bone Biology Tutorial*, and on completion of all program activities.

The **Bone Quest** materials, once completed, implemented and evaluated, will be made available for web-based use. Our team has an extensive history of software development, web-based educational activities, and educational outreach activities. We have worked with school districts locally and across the nation, we have participated in development of museum displays and classroom educational materials. Examples of some of these previous projects are attached in Appendix C. The attached Food Frequency Questionnaire is a software program developed for use on the International Space Station. The other curriculum examples were developed for use in local middle and high schools. Our extensive experience in this area will provide a opportunity to exploit existing partnerships in the assessment, evaluation, and dissemination of these educational materials.

MANAGEMENT PLAN

Scott M. Smith, Ph.D., Principal Investigator, is a Research Nutritionist with NASA at the Johnson Space Center. Dr. Smith has conducted research regarding effects of space flight on nutritional and physiological status, including effects on bone and calcium metabolism during space flight. Dr. Smith has been involved extensively with educational outreach of Nutritional Biochemistry Laboratory activities. His primary

responsibilities will include design, development, testing, and application of the educational outreach material proposed herein. Dr. Smith will devote 10% of his time to this project.

Janis Davis-Street, Co-Investigator, is a Nutritional Biochemist at the Johnson Space Center, and a doctoral student at the University of Houston. Ms. Davis-Street has been involved with research investigating the effects of space flight on nutritional and physiological status, including effects on bone and calcium metabolism during space flight. She has also been involved in the design and development of dietary assessment software used during long duration missions. She has been involved in the design of several novel education outreach materials, which have been used by Space Center Houston, the Texas Agricultural Extension Service, and the National Science Teachers Association (see Appendix C). Ms. Davis-Street's primary responsibilities will include coordination with education and technology consultants, and design, development, implementation, and evaluation of the educational outreach material proposed herein. She will devote 50% of her time to this project.

Steven A. Abrams, M.D, Co-Investigator, is a Professor at the Children's Nutrition Research Center/Baylor College of Medicine in Houston. Dr. Abrams is a world-renowned expert in the field of calcium and mineral metabolism in children and adolescents. Dr. Abrams will be involved in the design, evaluation, and eventual application of the educational outreach material proposed herein. Dr. Abrams will devote 5% of his time to this project.

EVALUATION PLAN

Phase 1: Primary Needs Assessment

High school educators and a convenience sample of adolescents will complete a questionnaire on attitudes toward technology, use and perceived skill, learning style with technology, technology access, and design preferences of students and teachers in both health and science education prior to the development of the interactive multimedia activities. The research team will use this information to identify needs and propose solutions.

Phase 2: Content Validity of Instructional Units

Content experts in the areas of Bone and Space Biology will assess the validity of material presented in all activities in ***Bone Quest***. In addition, the curriculum materials will be evaluated to ensure that national and state standards are met and supported (e.g., Texas Essential Knowledge and Skills - TEKS, and the National Pathways to the Science Standards).

Phase 3: Formative Evaluation

Several field tests of the Instructional Technology (IT) components will be implemented. Focus groups consisting of students and educators will provide qualitative assessment of the IT components. Questionnaires, observations, and

interviews will be used to collect data for the formative evaluation. Questions will be geared to assess the project concept and design and implementation. Context-specific questions will also be asked in order to fine-tune the evaluation process, including a quantitative and qualitative assessment of factors influencing implementation of the unit into classrooms will be conducted.

Phase 4: Summative Evaluation

A focus group will be used to provide the summative evaluation of **Bone Quest**. This evaluation will determine the ability of the curriculum to address the current project outcomes as described below. A rubric will be developed to assess an increase in student knowledge after exposure to **Bone Quest**. Specifically, students should score higher on their post-test scores when compared to scores obtained prior to exposure to the *Bone Biology Tutorial*. A rubric will also be developed to assess changes in attitudes about bone health, and behavioral intent after the tutorial and again after the application materials.

In the application activities (the *Building Better Bones* Series), students should score at least 300 points on their first attempt at the *Building Better Bones* In Space activity, and at least 450 points on subsequent attempts. Students should also demonstrate an improvement in their own bone health behaviors. This will be demonstrated by the achievement of higher scores after completion of the *Building Better Bones* on Earth activity.

Teacher interviews and a written questionnaire will be used to ascertain teacher satisfaction with use of the unit and recommended changes during the project pilot. In addition, measurement of student exposure level to the lessons in the unit will be assessed.

Table 1: Outcome Measures by Objectives and Outcomes

Objectives	Outcomes	Outcome Measures
High school students will be able demonstrate an increase in their knowledge about bone biology and bone health after completion of the <i>Bone Biology Tutorial</i> .	<ol style="list-style-type: none"> 1. Student knowledge of normal bone biology 2. Student knowledge of bone biology in a microgravity environment 3. Student knowledge of osteoporosis 4. Student knowledge of treatment modalities for space- and Earth-based bone loss 5. Student bone-related nutrition knowledge and behavior 	<ul style="list-style-type: none"> • Pre- and posttest scores (administered before and after the <i>Bone Biology Tutorial</i>.) • Scores from the <i>Building Better Bones in Space Series</i>
High school students will demonstrate an increase in positive attitudes and behavioral intent will be demonstrated	<ol style="list-style-type: none"> 1. Increase in attitudinal scores 	<ul style="list-style-type: none"> • Pre- and posttest scores (administered before and after the <i>Bone Biology Tutorial</i>, and after the <i>Building Better Bones in Space Series</i>)
High school students will demonstrate improved bone health behavior.	<ol style="list-style-type: none"> 1. Increase in reported intakes of calcium-containing food items 2. Decreased consumption of carbonated beverages 	<ul style="list-style-type: none"> • Scores from the <i>Building Better Bones on Earth Series</i>

This project draws on the expertise of nutritional scientists, experts in the area of calcium and bone metabolism, and the areas of health education, evaluation and instructional technology. The intended educational outcomes of the materials produced, an increase in student knowledge of bone biology and health in microgravity and on Earth, and positive changes in attitude and bone health behavior will be adequately assessed as described above. This proposal highlights current research activities in space biology, and presents a novel application of the microgravity environment for the study of human biology and health.

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3. Anderson JJB, SC Garner. (1995). Dietary issues of calcium and phosphorus. In: Calcium and phosphorous in health and disease, JJB Anderson, SC Garner, (Eds), CRC Press, Boca Raton, pp. 7-23.

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APPENDIX A

Vita – SM Smith, Ph.D.

JE Davis-Street, MS

SA Abrams, MD

P. Gingiss, Dr. P.H.

S. McNeil, Ed.D.

BIOGRAPHICAL SKETCH			
NAME Scott M. Smith		POSITION TITLE Research Nutritionist	
EDUCATION/TRAINING			
INSTITUTION(S) AND LOCATION	DEGREE(S)	YEAR(S)	FIELD OF STUDY
Penn State University, University Park, PA	B.S.	1985	Biology
Penn State University, University Park, PA	Ph.D.	1990	Nutrition

Professional Experience

1985-1990	Research Assistant, Nutrition Department, Penn State University
1990-1992	Postdoctoral Res Assoc, USDA- Human Nutrition Res Center, Grand Forks, ND
1992-1993	Scientist, Nutritional Biochemistry Lab, KRUG Life Sciences
1993-1994	Project Scientist/Supervisor, Nutrition and Metabolism, KRUG Life Sciences
1996-1999	Project Scientist, NASA/Mir Program - Human Life Sciences, NASA JSC
1994-present	Research Nutritionist, NASA Johnson Space Center, Houston, TX

Honors and Awards

NASA Outstanding Performance Award. 1995, 1996, 1997, 1998, 1999.
 NASA Group Achievement Award. HLS team for replanning following Spektr incident, 1998.
 NASA Group Achievement Award. Science Discipline Teams for NASA/Mir Incr. 4, 1998.
 NASA Group Achievement Award. Phase IIA ISS Life Support Test Project Medical Sci, 1997.
 NASA Group Achievement Award. Science Disciplines for NASA/Mir Incr. 2/STS-79, 1997.
 Health and Human Development Alumni Emerging Professional Award, Penn State, 1996.
 United States Department of Agriculture, Certificate of Merit, 1991.
 American Institute of Nutrition Predoctoral Fellowship, 1989.

Publications

- Tobin BW, Leeper-Woodford SK, Hashemi BB, Smith SM, Sams CF. Altered TNF- α , glucose, insulin, and amino acids in islets of Langerhans in a microgravity model system. *Am J Physiol (in press)*
- Smith SM, ME Wastney, BV Morukov, IM Larina, LE Nyquist, SA Abrams, EN Taran, C-Y Shih, JL Nillen, JE Davis-Street, BL Rice, HW Lane. Calcium metabolism before, during, and after a 3-month space flight: kinetic and biochemical changes. *Am J Physiol* 277:R1-R10, 1999.
- Smith SM, Nillen JL, LeBlanc A, Lipton A, Demers L, Lane HW, Leach CS. Collagen crosslink excretion during space flight and bed rest. *J Clin Endo Metab* 83:3584-3591, 1998.
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- Smith SM, Finley J, Johnson LK, Lukaski HC. Indices of *in vivo* and *in vitro* thyroid hormone metabolism in iron-deficient rats. *Nutr Res* 14:729-739, 1994.
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- Pekary A, Lukaski H, Mena I, Smith SM, Bhasin S, Hershman JM. Physiologic testosterone increases TRH biosynthesis in epididymis but not heart of zinc-deficient rats. *Peptides* 14:315-324, 1993

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- Smith SM, JE Davis-Street, BL Rice, Nillen JL, PL Gillman, G Block. Nutritional status assessment in semi-closed environments: ground-based and space flight studies. *Am J Clin Nutr* (in review)

Book Chapters/Review Articles

- Smith SM, Lane HW. Nutritional support. In: Barratt MR, Pool SL, eds. *Principles of Clinical Medicine for Space Flight*. New York, NY: Springer-Verlag, (in press)
- Lane HW, Smith SM, Bourland CT. Nutrition and foods as related to space flight. In: Nicogossian AE, Pool SL, Huntoon CL. *Space Physiology and Medicine*, 4th ed. Williams & Wilkins (in press)
- Huntoon CL, Cintrón N, Whitson, PA, Smith SM. Endocrine and Metabolic Functions. In: Nicogossian AE, Pool SL, Huntoon CL. *Space Physiology and Medicine*, 4th ed. Williams & Wilkins (in press)
- Smith SM, Feedback DL. Point-of-care testing in space and at high altitude. In: *Point-of-Care Testing: Principles, Management, and Clinical Practice* Ed. GJ Kost, McGraw-Hill, Ch 35. (in press)
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- Smith SM, Lukaski HC. Dietary iron: Deficiency or excess. In: *Methods in Nutrition Research - Volume 1* Ed. RR Watson, Boca Raton: CRC Press, pp. 51-57, 1996.
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- Lane HW, Smith SM, Rice BL, Bourland CT. Nutrition in space: Lessons from the past applied to the future *Am J Clin Nutr* 60:801S-805S, 1994.

Technical Briefs/Patents

- A unique urine preservative with antibacterial and antioxidant properties. JL Nillen, SM Smith (NASA Technical Brief MSC-22695, patent pending).
- A novel random-sample urine collection device for use on Shuttle. JE Davis-Street, JL Nillen, HW Lane, SM Smith. (NASA Tech Brief MSC-22748).
- Determination of ferritin iron content using inductively coupled plasma emission spectrometry techniques. P Gillman, SM Smith. (NASA Technical Brief MSC-23130-1, patent under consideration).
- A Food Frequency Questionnaire for determination of nutrient intake during space missions. SM Smith, JE Davis-Street, BL Rice, C Desai, G Block (MSC-23283-1, patent under consideration).

Research Projects Ongoing or Completed During the Last 3 years

- **Calcium kinetics during extended-duration space flight (E381) - International Space Station Early Utilization Science Program and Space Shuttle mission STS-107** NRA 96-HEDS-04/05. PI: SM Smith. 1998-present. This study will determine changes in calcium metabolism during and after space flight.
- **Iron absorption and metabolism during space flight (E124) - International Space Station Early Utilization Science Program** NRA 98-HEDS-02 PI: SM Smith. 1999-present. This study will determine changes in iron absorption during and after extended-duration space flight.
- **Use of alendronate or resistive exercise as bone loss countermeasure -ground-based bed rest studies** PIs: A LeBlanc, L Shackelford. SM Smith, Co-I. 1997-present. This is a ground-based study to evaluate potential bone and muscle loss countermeasures
- **Lower body negative pressure exercise to prevent physiologic deconditioning associated with space flight.** PIs: CJ Rogers, RS Meyer (UCSD). SM Smith, Co-I. 1999-present. This is a ground-based study to evaluate potential bone and muscle loss countermeasures
- **Exercise Training on Short-Arm Centrifuge.** PI: JE Greenleaf. SM Smith, Collaborator. 1998-present. This is a ground-based study to evaluate potential bone and muscle loss countermeasures
- **A ground-based study of the Russian exercise countermeasures program and a new resistance exercise countermeasure** NRA 98-HEDS-02. PI: SM Schneider. SM Smith, Co-I. 1999-present. This is a ground-based study to evaluate potential bone and muscle loss countermeasures
- **Development of a novel device to determine hormone concentrations during space flight.** NRA 99-HEDS-03. PI: M Dunn. SM Smith, Co-I. 2000-present. This study will develop hardware to enable real-time analysis of biochemical and endocrine during space flight.
- **Bone turnover changes in hypocaloric nutrition and immobilisation** European Space Agency AO-LS-2000-BR-SHORT-026. PI: M Heer SM Smith, Co-I. (Approved, 2000) This study will assess the impact of undernutrition on adaptation to weightlessness using a ground-based model.

BIOGRAPHICAL SKETCH

NAME Janis Davis-Street		POSITION TITLE Nutritional Biochemist	
EDUCATION/TRAINING			
INSTITUTION(S) AND LOCATION	DEGREE(S)	YEAR(S)	FIELD OF STUDY
University of Guelph, Ontario, Canada	B.S.	1985	Applied Human Nutrition
Univeristy of Alberta, Alberta, Canada	M.S.	1988	Nutrition
University of Houston, Texas, U.S.	Ed. D.	in progress	Health Education

Professional Experience

1985-1987 Graduate Research Assistant, Nutrition Department, University of Alberta
 1988-1991 Research Technician, USDA/ARS Children's Nutrition Research Center
 1991-present Nutritional Biochemist, Nutritional Biochemistry Laboratory (Wyle/EASI), NASA Johnson Space Center, Houston, TX

Honors and Awards

NASA Group Achievement Award. Phase 1 Program Team, 1998.
 NASA Group Achievement Award. Space Lab Life Sciences, 1994
 NASA Certificate of Recognition, 1996
 Alberta Heritage Foundation for Medical Research Fellowship, 1987
 Alberta Heritage Foundation for Medical Research Fellowship, 1986

Publications

- Smith SM, **JE Davis-Street**, BL Rice, Nillen JL, PL Gillman, G Block. Nutritional status assessment in semi-closed environments: ground-based and space flight studies. *Am J Clin Nutr* (in review)
- Smith SM, ME Wastney, BV Morukov, IM Larina, LE Nyquist, SA Abrams, EN Taran, C-Y Shih, JL Nillen, **JE Davis-Street**, BL Rice, HW Lane. Calcium metabolism before, during, and after a 3-month space flight: kinetic and biochemical changes. *Am J Physiol* 277:R1-R10, 1999.
- Smith SM, **Davis-Street JE**, Fontenot TB, Lane HW. Assessment of a portable clinical blood analyzer during space flight. *Clin Chem* 43:1056-1065, 1997.
- Lane HW, Gretebeck RJ, Schoeller DA, **Davis-Street J**, Socki RA, Gibson EK. Comparison of ground-based and space flight energy expenditure and water turnover in middle-aged healthy male US astronauts. *American Journal of Clinical Nutrition* 65:4-12, 1997.
- Gretebeck RJ, Schoeller DA, Socki RA, **Davis-Street J**, Gibson EK, Schultz LO, Lane HW: Adaptation of the doubly labeled water method for subjects consuming isotopically enriched water. *Journal of Applied Physiology*, 82:563-570, 1997.
- Ferrando AA, Lane HW, Stuart C, **Davis-Street JE**, Wolfe R. Prolonged bed rest decreases skeletal muscle and whole-body protein synthesis. *American Journal of Physiology* 270:E627-E633, 1996.

Technical Briefs/Patents

- A novel random-sample urine collection device for use on Shuttle. JE Davis-Street, JL Nillen, HW Lane, SM Smith. (NASA Tech Brief MSC-22748).
- A Food Frequency Questionnaire for determination of nutrient intake during space missions. SM Smith, JE Davis-Street, BL Rice, C Desai, G Block (MSC-23283-1, patent under consideration).

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel in the order listed on Form Page 2.
Photocopy this page or follow this format for each person.

NAME Steven A. Abrams		POSITION TITLE Professor of Pediatrics	
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing. Include postdoctoral training.)			
INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
Massachusetts Inst. of Technology	BS	1975-1979	Biology
Ohio State University	MD	1979-1982	Medicine
Children's Hospital Med Ctr of Akron		1982-1985	Pediatrics
Baylor College of Medicine		1985-1988	Neonatology/Nutrition

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications.

Professional Experience:

- 1988 - 1991 **NRSA Fellow**, National Institute of Child Health and Human Development, Laboratory of Theoretical and Physical Biology, Bethesda, Maryland
- 1988 - 1991 **Clinical Assistant Professor of Pediatrics**, George Washington University Washington, D.C.
- 1991- 1995 **Assistant professor of Pediatrics**, Baylor College of Medicine and USDA/ARS Children's Nutrition Research Center, Houston, Texas
- 1995- 2000 **Associate professor of Pediatrics**, Baylor College of Medicine and USDA/ARS Children's Nutrition Research Center, Houston, Texas
- 2000- **Professor of Pediatrics**, Baylor College of Medicine and USDA/ARS Children's Nutrition Research Center, Houston, Texas

Awards and other Professional Activities

- 1996-1997 - Institute of Medicine's (Food and Nutrition Board) "**Panel on Calcium and Related Nutrients**"
- 1996-1997 - Institute of Medicine's (Food and Nutrition Board) "**Subcommittee on Upper Safe Reference Levels of Nutrients**"
- 1998 - Present - Mentor/Committee member: Pediatric Gastroenterology Training Grant (NIH-Sponsored), Dept. Pediatrics, Baylor College of Medicine:
- 1999 - **Norman Kretchmer Memorial Award** in Nutrition and Development (American Society for Clinical Nutrition)
- 2000 - **Centrum Center for Nutrition Science Award** (American Society for Nutritional Sciences)

Research Projects Ongoing or Completed During the Last 3 years

Adaptive mechanism to low calcium intake during puberty. 1998-2001. NICHD (1 RO1 HD36591-01). S Abrams, Principal Investigator. This study evaluates the consequences of low calcium intakes on calcium metabolism in young adolescent females.

Determinants of pubertal changes in bone mineral metabolism. 1996 - 2001. NIAMS (1 RO1 AR 43740-01). S. Abrams, Principal Investigator. This study evaluates the biochemical, hormonal and calcium metabolic consequences of puberty in groups of Caucasian, Mexican-American and African-American females.

Zinc metabolism in healthy children and those with chronic inflammatory bowel disease.

1999-2001 - Crohn's and Colitis Foundation of America. S Abrams, Principal Investigator. This project evaluates the effects of chronic inflammatory bowel disease on zinc absorption, excretion and kinetics in children.

Iron absorption from fortified wheat flour: The effect of adding zinc and/or vitamin A. 1999-2001 – Nestlé's Research Foundation, N Zavaleta, PI, S Abrams, Co-Investigator. This study is evaluating the absorption of iron and zinc in Peruvian children who receive mineral fortified wheat flour products.

Absorption and metabolism of dietary minerals in infants and children USDA/ARS.1999-2002.- CRIS: 58-6250-1-003. S Abrams, PI. This project evaluates the absorption and kinetics of calcium and zinc in healthy children.

Evaluation of the effects of non-absorbable oligosaccharides on calcium absorption in adolescent girls 1999 – 2000. Orafiti, Inc. , S Abrams, Principal Investigator. This study evaluates the effects of adding non-absorbable oligosaccharides on calcium absorption in adolescent females.

Calcium absorption from lactose-free compared to lactose-containing infant formula. 1999- 2000. Nestlé's USA. S Abrams, Principal Investigator. This study evaluates the effects of low-lactose infant formulas on calcium and zinc absorption in infants.

Relevant Publications: (Selected from 73 peer-reviewed articles)

1. Abrams SA, Sidbury JB, Muenzer A, Esteban NV, Vieira NE, Yergey AL. Stable isotopic measurement of endogenous fecal calcium excretion in children. *J Pediatr Gastroenterol Nutr* 1991;12:469-73.
2. Abrams SA, Esteban NV, Vieira NE, Yergey AL. Dual tracer stable isotopic assessment of calcium absorption and endogenous fecal excretion in low birth weight infants. *Pediatr Res* 1991;29:615-8.
3. Abrams SA, Esteban NV, Vieira NE, Sidbury JB, Specker BL, Yergey AL. Developmental changes in calcium kinetics in children assessed using stable isotopes. *J Bone Min Res* 1992;7:287-293.
4. Abrams SA, Lipnick RN, Vieira NE, Stuff J, Yergey AL. Calcium absorption in children with juvenile rheumatoid arthritis assessed using stable isotopes. *J Rheumatol* 1993;20:1196-1200.
5. Abrams SA, Silber TJ, Esteban NV, Vieira NE, Stuff JE, Meyers R, Majd M, Yergey AL. Mineral balance and bone turnover in adolescents with anorexia nervosa. *J Pediatr* 1993;123:326-31.
6. Abrams SA. Pubertal changes in calcium kinetics in girls assessed using ⁴²Ca. *Pediatr Res* 1993;34:455-9.
7. Abrams SA, Yergey AL, Schanler RJ, Vieira NE, Welch TR. Hypercalciuria in premature infants receiving high mineral-containing diets. *J Pediatr Gastroenterol Nutr* 1994;18:20-4.
8. Murras N, Haymond MW, Darmaun D, Vieira NE, Abrams SA, Yergey AL. Protein and calcium kinetics in prepubertal boys: Positive effects of testosterone. *J Clin Invest* 1994;93:1014-19.
9. O'Brien KO, Abrams SA. Effects of development on techniques for calcium stable isotope studies in children. *Biol Mass Spectromet* 1994;23:357-61.
10. Abrams SA. Clinical studies of mineral metabolism in children using stable isotopes. *J Pediatr Gastroenterol Nutr* 1994;19:151-63.
11. Abrams SA, Schanler RJ, Yergey AL, Vieira NE, Bronner F. Compartmental analysis of calcium metabolism in very low birth weight infants. *Pediatr Res* 1994;36:424-8.
12. Abrams SA, Stuff JE. Calcium metabolism in girls: current dietary intakes lead to low rates of calcium absorption and retention during puberty. *Am J Clin Nutr* 1994;60:739-43.
13. Abrams SA, Yergey AL, Heaney RP. Relationship between balance and dual tracer isotopic measurements of calcium absorption and excretion. *J Clin Endocrinol Metab* 1994;79:965-9.
14. Abrams SA, O'Brien KO, Liang LK, Stuff JE. Differences in calcium absorption and kinetics between black and white girls age 5-16 years. *J Bone Min Res* 1995;10:829-33.
15. Abrams SA, O'Brien KO, Stuff JE. Changes in calcium kinetics associated with menarche. *J Clin Endocrinol Metab* 1996;81:2017-2020.
16. Abrams SA, Wen J, Stuff JE. Absorption of calcium, zinc and iron from breast milk by 5- to 7-month-old infants. *Pediatr Res* 1997;41:384-390.
17. Abrams SA, Grusak MA, Stuff J, O'Brien KO. Calcium and magnesium balance in 9- to 14-year-old children. *Am J Clin Nutr* 1997;66:1172-1177.
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24. Abrams SA. Insights into bone metabolism from calcium kinetic studies in children. *Adv Exp Med Biol* 1998;445:283-291.
25. Bronner F, Abrams SA. Development and regulation of calcium metabolism in healthy girls. *J Nutr* 1998;128:1474-1480.
26. McDonald MC, Abrams SA, Schanler RJ. Iron absorption and red blood cell incorporation in premature infants fed an iron-fortified infant formula. *Pediatr Res* 1998;44:507-511.
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31. Abrams SA, Copeland KC, Gunn SK, Stuff JE, Clarke LL, Ellis KJ. Calcium absorption and kinetics are similar in 7- and 8-year-old Mexican-American and Caucasian girls despite hormonal differences. *J Nutr* 1999;129:666-671.
32. Ames SK, Ellis KJ, Gunn SK, Copeland KC, Abrams SA. Vitamin D receptor gene *FokI* polymorphism predicts calcium absorption and bone mineral density in children. *J Bone Miner Res* 1999;14:740-746.
33. Ames SK, Gorham BM, Abrams SA. Effects of high vs low calcium intake on calcium absorption and red blood cell iron incorporation by small children. *Am J Clin Nutr* 1999;70:44-48.
34. Ellis KJ, Abrams SA, Wong WW. Monitoring childhood obesity: Assessment of the weight/height² index. *Am J Epidemiol* 1999;150:939-946.
35. Moody GJ, Schanler RJ, Abrams SA. Utilization of supplemental iron by premature infants fed fortified human milk. *Acta Paediatrica* 1999;86:763-767.
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37. Abrams SA. Using stable isotopes to assess mineral requirements in children. *Am J Clin Nutr* 1999;70:955-64.
38. Vieira NE, Marini JC, Hopkins E, Abrams SA, Yergey AL. Effect of growth hormone treatment on calcium kinetics in patients with Osteogenesis Imperfecta Type III and IV. *Bone* 1999;25:501-505.
39. Abrams SA, Copeland KC, Gunn SK, Gundberg CM, Klein KO, Ellis KJ. Calcium absorption, bone accretion and kinetics are increased during early pubertal development in girls. *J Clin Endocrinol Metab* 2000, In press.
40. Feillet-Coudray C, Coudray C, Brûlé F, Gueux E, Mazur A, Abrams SA, Rayssiguier Y. Exchangeable magnesium pool masses in rats are related to magnesium status. *J Nutr*, 2000;130:2306-2311.
41. O'Brien KO, Zavaleta N, Caulfield LE, Wen J, Abrams SA. Influence of prenatal iron supplements on zinc absorption during pregnancy. *J Nutr* 2000;130: 2251-2255.
42. Griffin I, Abrams SA. Compartmental modeling of zinc metabolism in young girls: An extended stable isotope model and a comparison with adult data. *J Nutr* 130: Oct. 2000.

Other Publications

1. Committee on Nutrition, American Academy of Pediatrics: Calcium requirements of infants, children, and adolescents. *Pediatrics*; 1999;104:1152-1157.(consultant/statement author).
2. Abrams SA. The importance of vitamins and minerals in preschool and school-aged children: impact on childhood health and adult development. CME monograph. Postgraduate Institute for Medicine, Littleton, CO, 1999.
3. Abrams SA. Calcium Requirements in infants, children, and adolescents. In: Lifschitz CL, ed. *Pediatric Gastroenterology and Nutrition in Clinical Practice*. Marcell Dekker, Inc. New York, NY. (In Press).

BIOGRAPHICAL SKETCH

NAME Phyllis M. Gingiss		POSITION TITLE Professor, Public Health Education – University of Houston	
EDUCATION/TRAINING			
INSTITUTION(S) AND LOCATION	DEGREE(S)	YEAR(S)	FIELD OF STUDY
University of Texas School of Public Health- National Cancer Institute Post-Doctoral Fellow	Fellowship	1992-1990	Cancer Prevention
University of Texas School of Public Health	Dr.P.H.	1980	Hlt. Promotion Ed.
University of Texas School of Public Health	M.P.H.	1976	Community Hlt.
University of Houston	B.S.	1961	Secondary Education

Professional Certification: Certified Health Education Specialist (CHES): 1989 - present.

Academic Appointments

Professor of Public Health Education, Department of Health and Human Performance, College of Education, UH, 1993 - present; Associate Professor, 1987-1993; Assistant Professor: 1980-1987. Associate Dean of Research, College of Education, University of Houston: 1994-1998. Chair, University Research Council: 1997-1998. Coordinator of Graduate and Undergraduate Health Programs, Department of Health and Human Performance, College of Education, UH (1998-present); Graduate Director: 1992-1994. Adjunct Professor, Dept. of Family & Community Medicine, Baylor College of Medicine, 1980 -present.

Honors and Awards

1999 Healthway Visiting Research Fellow. Sponsored by the Western Australian Collaborative Centre for Public Health (includes University of Western Australia, Curtin University, and Healthway Foundation). Perth, Australia, June/July, 1999. Fellow, American School Health Association, Fall, 1993. Fellow, Research Consortium, American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD), Spring, 1991. Martha Licata Award for Outstanding Contributions to the Texas School Health Association, 1992.

REPRESENTATIVE PUBLICATIONS SINCE 1990. (from >100 manuscripts, abstracts & reports).

Bosworth, K., Gingiss, P., Potthoff, S., Roberts-Gray, C. (1999). A Bayesian model to predict the success of the implementation of a health education innovation. *Journal of Evaluation and Program Planning* 22:1-11.

Weller, N.F., Tortolero, S.R., Kelder, S.H., Grunbaum, J.A., Carvajal, S.C., Gingiss, P.M. (1999). The prevalence of health risk behaviors of Texas alternative school students attending dropout prevention/recovery schools in 1997. *Journal of School Health*. 69(1):22-28.

Grunbaum, J.A., Tortolero, S., Weller, N., Gingiss, P. (2000). Cultural, social and intrapersonal factors associated with substance use among alternative high school students. *Addictive Behaviors*. 25(1):145-151.

Gingiss, P.M. Implementation of prevention programs in schools: Barriers and remedies. Invited manuscript prepared for the NIH sponsored task force: Planning Prevention Programs for Public Schools (1998). Sponsored by the Substance Abuse Education Institute, University of Arizona, Tucson. Final publication is being included in a special journal edition pertaining to Planning for Health Prevention Programs in the 21st Century (in press).

Gingiss, P.M. (1996/97). Building a Future Without Aids. Position Paper for the American Association of Colleges for Teacher Education, Washington, DC. Distributed to all Deans and Administrators at Institutions of Higher Education involved with teacher education.

- Smith, P. S. & Gingiss, P. L. (1996). Characteristics of pregnant adolescents receiving prenatal care at school-based or hospital-based clinics. Journal of Health Education. 27(1):30-37.
- Gingiss, P. & Engel, M. Factors influencing the likelihood of successful implementation of school health centers. Proceedings of the annual meeting of the American School Health Association, Milwaukee, WI. October 26, 1995.
- Gingiss, P. & Engel, M. Staff development and educational technology needs of school-based health centers. Proceedings of the annual meeting of the American School Health Association, Milwaukee, WI. October 26, 1995.
- Grunbaum, J.A., Gingiss, P., Orpinas, P., Batey, L.S., & Parcel, G.S. (1995). A comprehensive approach to school health program needs assessments. Journal of School Health. 65(2):54-59.
- Gingiss, P. L. & Basen-Engquist, K. (1994). HIV education practices and training needs of middle school and high school teachers. Journal of School Health. 64(8):290-295.
- Rhodes, J.E., Gingiss, P. L., & Smith, P. S. (1994). Risk and protective factors for alcohol use among pregnant African-American, hispanic, and white adolescents. Addictive Behaviors. 19(5):555-564.
- Basen-Engquist, K., O'Hara-Tompkins, N., Lovato, C.Y., Lewis, M. J., Parcel, G.S. & Gingiss, P. (1994). The effect of two types of teacher training on implementation of Smart Choices: A tobacco prevention curriculum. Journal of School Health. 64(8):334-339.
- Gingiss, P.L., Gottlieb, N.H., & Brink, S. G. (1994). Measuring cognitive characteristics associated with adoption and implementation of health innovations in schools. American Journal of Health Promotion. 8(3):294-301.
- Gingiss, P.L., Gottlieb, N.H. & Brink, S.G. (1994). Increasing teacher receptivity towards use of tobacco prevention education programs. Journal of Drug Education. 24(2):163-176.
- Gottlieb, N.H., Brink, S.G. & Gingiss, P.L. (1993). Correlates of coalition effectiveness: The Smoke Free Class of 2000 program. Health Education Research. 8(3):375-384.
- Hamilton, R. & Gingiss, P.L. (1993). The relationship of teacher attitudes to course implementation and student responses. Teaching and Teacher Education: An International Journal of Research and Studies. 9(2):193-204.
- Gingiss, P.L. (1993). Peer coaching: Building collegial support for use of innovative health programs. Journal of School Health 63(2):82-88.
- Gottlieb, N., Gingiss, P.L. & Weinstein, R. (1992). Attitudes, subjective norms and models of use for smokeless tobacco among college athletes: Implications for prevention and cessation programming. Health Education Research. 7(3):359-368.
- Gingiss, P.L. (1992). Enhancing program implementation and maintenance through a multiphase approach to peer-based staff development. Journal of School Health, 62(5):161-166.
- Brink, S.G., Gingiss, P.L. & Gottlieb, N.H. (1991). An evaluation of the effectiveness of a planned diffusion process: Smoke-Free Class of 2000 Project in Texas. Health Education Research. 6:183-191.

REPRESENTATIVE GRANTS OR PROJECTS (since 1990)

- Texas Department of Health. Texas Tobacco Prevention and Control Pilot Study. Principal Investigator. Establishment of the Statewide Tracking and Surveillance System for the Texas Tobacco Settlement Fund. Collection of baseline data using over six questionnaires involving qualitative and quantitative data. (FY2000-2001).
- Christian Health Ministries Foundation. Greater New Orleans Early Childhood Immunization Program: Five year evaluation. Principal Investigator (1998-2003).
- Episcopal Health Charities. Needs assessment and program development for a technology-based educational intervention to serve transfer students and children with special needs. Subcontract through Rusk School Health Promotion Program. Principal Investigator (1998-1999).

Cullen Foundation. Establishment of the "User-Friendly College" through technology. 2 years. Project Director, College of Education, 1995-1997. Research and development of a comprehensive college web-site and CD-ROM.

DeWitt Wallace-Reader's Digest Fund and Fordham University. University of Houston Social Work/Education Collaborative. 3 years. Project Director, College of Education, 1994-96.

Texas Department of Health, Office of Maternal and Child Health. Evaluation of the implementation of the school health programs, 1993-1994. 9 months. Principal Investigator: Dr. Phyllis Gingiss.

Centers for Disease Control through the Southwest Center for Prevention Research. Student Health for the Year 2000. 1991-1994/3 years. Principal Investigator: Guy Parcel, Ph.D., University of Texas Center for Health Promotion Research and Development, Houston. Dr. Phyllis Gingiss, Co-Investigator.

Texas Cancer Council. Expanded data analysis and program recommendations for diffusion of the Smart Choices Tobacco Prevention Program. Spring/Summer, 1992. Principal Investigators: Dr. Phyllis Gingiss and Dr. N. O'Hara-Tompkins, University of Texas Center for Health Promotion Research and Development, Houston.

Integrating Tobacco Prevention Programs in Schools. National Cancer Institute. Principal Investigators: Dr. Guy Parcel, UT Center for Health Promotion Research and Dr. Michael Eriksen, MD Anderson Cancer Center. {PLG served as a co-investigator from 1990-1991}.

Diffusion of Smoke-Free 2000 Educational Materials Among First Grade Teachers in Texas. National Coalition of Smoke-Free 2000 (American Cancer Society, American Heart Association, and American Lung Association). 1989. Principal Investigator with Dr. Nell Gottlieb and Dr. Susan Brink, University of Texas Center for Health Promotion.

INTERNATIONAL AND NATIONAL ADVISORY BOARDS: In 1999, Dr. Gingiss served as an advisor to administrators in the Western Australian Departments of Health and Education, staff of voluntary health agencies (e.g. Australian Cancer Society and Australian Heart Association), staff at numerous agencies serving children and youth, foundation directors, faculty and graduate students. Dr. Gingiss recently served on an Expert Panel to the Federal Bureaus of Primary Health Care and Maternal and Child Health, NIH, regarding Evaluation for the Healthy Schools, Healthy Communities Initiative; the National Task Force for HIV Prevention within Comprehensive School Health Education; and the Evaluation Advisory Group of the National Center for Social Work and Education Collaboration at Fordham University. Active in the National Assembly of School-Based Health Centers, she also was a consultant to the National Institute of Medicine Task Force for Comprehensive School Health and has served on numerous national panels such as Applications of Computer-Based Technologies for the National Cancer Institute; American Cancer Society; American Heart Association and American Lung Association, on national review panels for the NIH, Department of Education; and Carnegie Council on Adolescent Development. A reviewer/editorial board member for numerous professional journals, Dr. Gingiss is currently working with several organizations/institutions within the U.S. for strengthening interprofessional education in preparation of collaborative school-community initiatives. International activities include work with colleagues from Amsterdam, the United Kingdom and Ireland to expand international collaborations to strengthen school-community partnerships in the U.S. and Europe.

VITA

Sara G. McNeil

Assistant Professor, Instructional Technology
Curriculum and Instruction, College of Education, University of Houston
4800 Calhoun, Houston, Texas 77204-5872
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Academic Degrees

Ed.D. (Curriculum and Instruction), The University of Tennessee, Knoxville, December 1993
M.S. (Art Education), The University of Tennessee, Knoxville, August 1992
B.F.A. (Art History and Interior Design), The University of Georgia, March 1973.

Professional Experience

Assistant Professor, Instructional Technology, University of Houston, 1995-present
Graduate Teaching Assistant, University of Tennessee, Knoxville, 1991-1995
First Grade Classroom Teacher, Grainger County School System, Rutledge, Tennessee, 1980-1991

Normal Current Assignments

CUIN 6373: Instructional Design
CUIN 7317: The Visual Representation of Information
CUIN 7320: The Design and Development of Print-Based Educational Materials
CUIN 7327: The Collaborative Design of Multimedia
CUIN 7357: The Collaborative Development of Multimedia
CUIN 8305: Advanced Information Technologies

Professional Certificates

Teaching Certificate, grades 1-8
Art Education Teaching Certificate, grades K-12

Current Professional and Academic Association Memberships

Member of the Association for the Advancement of Computing in Education (AACE)

Research/Development Area of Specialization

Visual Representation of Information
Collaborative Design and Development of Multimedia
Gender Equity in Math, Science and Technology
Constructing Online Learning Environments for Distance Education

Non-Teaching Professional Assignments and Activities

Indonesia Scholars Technology Consultant, Fall 1997
Research Initiation Grant, University of Houston, "Factors that Effect Cooperation, Collaboration and Communication in Education Multimedia Design Teams," \$6,000, June - August, 1997.
Limited Grant in Aid, University of Houston, "A Survey of Student Attitudes and Preferences about Web Pages as Curricular Resources," \$2,000, June - August, 1997.
Interdisciplinary Initiative Program, University of Houston, "The Cross-College Consortium On Technology Transfer," Collaborators: Dr. John Butler, Dr. D. Donnelly, Dr. S. McNeil, Dr. S. Mintz, Dr. B. Robin, Mr. M. Walters, \$50,000, August, 1996 - August, 1997
Preparing Tomorrow's Teachers to Use Technology, Department of Education, "Action Communities in Teaching Excellence." 2003, \$1.4 million

Professional Honors and Recognition

Outstanding Faculty Member in a Distance Education Program
A national teaching award given by the University Continuing Education Association, (April, 1998).
Outstanding Faculty Member in a Distance Education Program
A regional teaching award given by the University Continuing Education Association, REGION III, (October, 1998).
Junior Teaching Excellence Award, College of Education, (May, 1998)
Enron Teaching Excellence Award, May, 1999
Distance Education Teaching Excellence Award, May, 1999

Sara McNeil

Publications

- Robin, B., & McNeil, S. (1998). A theoretical framework for creating Webscapes: Educational information landscapes on the Web. In T. Ottmann & I. Tomek (Eds.), Educational Hypermedia and Multimedia 1998. (pp. 1816-1817). Charlottesville, VA: Association for the Advancement of Computing in Education.
- McNeil, S. (1998). Factors that Affect Cooperation, Collaboration and Communication in Educational Multimedia Design Teams. In S. McNeil, J. D. Price, S. Boger-Mehall, J. Willis, B. Robin (Eds.), Technology and Teacher Education Annual 1998. (pp. 665-670). Charlottesville, VA: Association for the Advancement of Computing in Education.
- McNeil, S., Price, J.D., Boger-Mehall, S., Robin, B., & Willis, J. (Eds.). (In Press). Technology and teacher education annual, 1998. Charlottesville, VA: Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1997). An archive of sharable educational resources on the web. In J. Willis, J. Price, S. McNeil, B. Robin & D. Willis (Eds.), Technology and teacher education annual 1997 (pp. 1271-1273). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1997). New directions for dealing with copyright: Archive.edu. In T. Muldner and T. Reeves (Eds.), Educational Hypermedia and Multimedia 1997. Charlottesville, VA: Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1997). Creating a course-based web site in a university environment. Computers & Geosciences, 23 (5), 563-572.
- Willis, J., Price, J.D., McNeil, S., Robin, B., & Willis, D.A. (Eds.). Technology and teacher education annual, 1997. Charlottesville, VA: Association for the Advancement of Computing in Education.
- McNeil, S. (1996). A practitioner validated list of competencies needed for courseware authoring. In B. Robin, J. Price, J. Willis & D. Willis (Eds.), Technology and Teacher Education Annual 1996 (pp. 338-343). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Little, J., McNeil, S., & Doak, D. (1996). University-school connections: From alpha to omega. In B. Robin, J. Price, J. Willis & D. Willis (Eds.), Technology and Teacher Education Annual 1996 (pp. 1001-1006). Charlottesville, VA: Association for the Advancement of Computing in Education.
- McNeil, S. (1996). A practitioner validated list of competencies needed for courseware authoring. In P. Carlson & F. Makedon (Eds.), Educational Hypermedia and Multimedia 1996 (pp. 459-464). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1996). Archive.edu: A storehouse of classroom resources on the Web. In H. Maurer (Ed.), WebNet 96, World Conference of the Web Society Proceedings. Charlottesville, VA: Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1996). Archive.edu: A storehouse of classroom resources on the Web. Reprinted in Computers and the Social Studies, 5 (4), available online: <http://www.cssjournal.com/journal/robin2.html>

Recent Conference Presentations

- McNeil, S. (1999, June). *Cooperation, Collaboration and Communication in Educational Multimedia Design and Development Teams*. Full paper, ED-MEDIA 99 - World Conference on Educational Multimedia and Hypermedia, Seattle, Washington. Association for the Advancement of Computing in Education
- McNeil, S. (October, 1998). Invited panel member, Western Governors University, Aurora, Colorado. Discussion on competencies for the Masters of Education Degree in Learning and Technology
- Robin, B. & McNeil, S. (1998, June). *A theoretical framework for creating Webscapes: Educational information landscapes on the Web*. Paper presented at ED-MEDIA 98 - World Conference on Educational Multimedia and Hypermedia, Freiburg, Germany. Association for the Advancement of Computing in Education.
- McNeil, S. & Robin, B. (1998, June). *Developing educational webscapes for higher education: The convergence of information landscapes and web-based learning*. A half-day workshop presented at ED-MEDIA 98 - World Conference on Educational Multimedia and Hypermedia, Freiburg, Germany. Association for the Advancement of Computing in Education.
- McNeil, S., Robin, B., and Birch, D. (April, 1997). *Developing Graphically Rich Web Environments for Education. Media in the Web Place: Creating Powerful Multimedia Resources for Education*. Two half-day workshops presented at SITE 97, Society for Information Technology and Teacher Education International Conference, April 1, 1997, Orlando, FL.
- McNeil, S. (1996, June). *A Practitioner Validated List of Competencies Needed for Courseware Authoring*. ED-MEDIA 96 - World Conference on Educational Multimedia and Hypermedia, Boston, MA. Association for the Advancement of Computing in Education.
- Robin, B. & McNeil, S. (1996, October). *Archive.edu: A storehouse of classroom resources on the Web*. WebNet 96, World Conference of the Web Society, San Francisco, CA. Association for the Advancement of Computing in Education.

APPENDIX B

Letters of Support: J.E. Davis-Street, M.S.

S. Abrams, M.D.

P. Gingiss, Dr.P.H.

S. Mcneil, Ed. D.



Enterprise Advisory Services, Inc.

September 11, 2000

Scott M. Smith, Ph.D.
Life Sciences Research Labs, SD3
NASA Johnson Space Center
Houston, TX 77058

Dear Dr. Smith.,

I am looking forward to collaborating with you on your proposed project titled "Bone Quest – A Space-Based Science and Health Education Unit." This project will be a valuable addition to the NSBRI's education outreach activities, and will provide high school students with a wonderful opportunity to learn more about the relationships between space, biology, and human health and disease. I will be happy to contribute my experience in designing novel educational activities and background in nutrition and health education to this project.

Sincerely,

A handwritten signature in black ink, appearing to read "Janis Davis-Street". The signature is fluid and cursive, with a vertical line extending downwards from the first letter "J".

Janis Davis-Street, M.S.



**BAYLOR
COLLEGE OF
MEDICINE**

Steven A. Abrams, MD
Department of Pediatrics
Children's Nutrition Research Center
Stable Isotope Laboratory
1100 Bates Street
Houston TX 77030
Office: 713-798-7124
FAX: 713-798-7119
sabrams@bcm.tmc.edu

September 8, 2000

Dr. Scott Smith
Nutritional Biochemistry Laboratory
NASA/Johnson Space Center/SD3
Houston TX 77058

Dear Dr. Smith

I would be pleased to be a co-investigator in your proposed project entitled "Bone Quest – A Space-Based Health Education Unit." I have reviewed the proposal and believe it can make an important contribution to the knowledge based of children regarding bone minerals as well as the physiology of space flight. The Children's Nutrition Research Center has considerable experience in nutritional education for children, especially as related to minerals. We would be glad to assist in any way possible in this valuable project to enhance bone and mineral knowledge in children.

Sincerely,

A handwritten signature in dark ink, appearing to read "Steven A. Abrams".

Steven A. Abrams, MD
Professor
USDA/ ARS Children's Nutrition Research Center and
Section of Neonatology
Department of Pediatrics
Baylor College of Medicine

U N I V E R S I T Y *of* H O U S T O N

College of Education

Department of Health and Human Performance

Houston, TX 77204-6321



September 12, 2000

Scott Smith, Ph.D.
Life Sciences Research Labs, SD3
NASA Johnson Space Center
Houston, TX 77058

Dear Dr. Smith,

I look forward to the opportunity to collaborate with Janis Davis-Street and your team on the project titled "Bone Quest - A Space-Based Science and Health Education Unit." The science and health education instructional materials to be produced, their innovative application through the web for wide-spread use, and the evaluation data to be studied promise exciting interactive enrichment of current programs, as well as insights into the optimal ways to use emerging web-based technologies to reach and modify the behaviors of high school students.

I understand that my role with this project will be to assist in the development, field testing, implementation and evaluation of the project. Much of my current evaluation work is centered around implementation of web-based programs in school and community programs. I appreciate the opportunity to blend my expertise in the development, implementation and evaluation of school and community-based programs and my background in use of emerging technologies to meet student educational needs with the goals of this project.

Sincerely,

A handwritten signature in cursive script that reads "Phyllis M. Gingiss".

Phyllis M. Gingiss, Dr.P.H.
Professor of Public Health Education

U N I V E R S I T Y of H O U S T O N

College of Education

Department of Curriculum and Instruction

Houston, TX 772 4-5872 713/743-4950



Janis Davis-Street
Nutritional Biochemistry Laboratory
NASA
Johnson Space Center
Houston, Texas

September 12, 2000

Dear Janis,

On behalf of the College of Education and the University of Houston, I am writing to convey our support for your grant proposal to National Space Biomedical Research Institute. As Houston's largest public university and one of the nation's most diverse, the University is committed to serving the educational needs of our city, and an important part is to ensure - through the College of Education - the public schools have quality educational curricula. In addition, our College strongly supports the creation of innovative learning environments in which our future teachers can experience the appropriate use of technology.

Our College is convinced that new technologies hold out the promise of helping us better meet the needs of students with diverse learning styles, reinforcing students skills, and promoting active learning and enhancing student and faculty interaction. By breaking down classroom walls and offering students opportunities to become more involved with problem-based learning, we can effectively model new learning strategies for the new millennium.

The development of educational materials that integrate bone physiology issues during space flight with Earth-based bone health issues such as osteoporosis is an interesting and vital topic for both teachers and students. Your ideas for environments that utilize multimedia tools in an interactive curriculum for secondary students are on the leading edge of technology. It is an example of innovative curricular ideas that incorporate nutrition and health education with space physiology.

Technology holds tremendous promise for education, and through the University of Houston College of Education, we are working to harness its power for the benefits of teachers and students. I am looking forward to working with you on this project.

I will be an active collaborator to help ensure the successful implementation of this project.

Sincerely,

A handwritten signature in cursive script that reads "Sara McNeil".

Sara McNeil, Ed.D.

Instructional Technology Program Area

APPENDIX C

Previously Developed Materials

Food Frequency Questionnaire

Have a Heart - Cosmic Classroom: A Space Presence

Bone Health – Cosmic Classroom: A Space Presence

Instructional Guide - Texas Agricultural Extension Service, 4H Leadership Lab

COSMIC

Space-Based Activities For Earth-Based Students

A SPACE PRESENCE



Module E: 9-12

CLASSROOM

Cosmic Classroom

Space-Based Activities For Earth-Based Students

Through the support of normal operations and private donations, Space Center Houston is dedicated to making its dynamic educational environment accessible to all schools for promoting science, math and technology education. The Center's inspiring exhibits, films, and educational attractions allow students to: experience the excitement of discovery, develop a better understanding of space exploration and the role science and technology play in our world, and associate science with real people as they observe scientists and engineers at work.

"Building Bridges to Better Education" is the goal of the Toyota USA Foundation. The Foundation is pleased to support the development and launch of Space Center Houston's Cosmic Classroom, a new kindergarten through 12th grade space-based curriculum for schools, because these modules encourage creative learning and set high standards for math and science education.



Space Center Houston is a non-profit project of the Manned Space Flight Education Foundation, Inc.

A Space Presence: Life Sciences

Module E: 9-12

Most high school teachers have some experience organizing thematic units. It means that the learning events for a day, a week, a month, or longer are organized around a central idea or concept. Students explore that concept through stories, games, library study and experiments.

The Cosmic Classroom project took the unifying theme of space and developed the knowledge and skills from math, science, language arts, social studies and the fine arts. By using the artifacts from the Human Spaceflight Program, and enlarging certain concepts of astronomy and earth science, teachers are able to build on their students' natural interests in stars, planets, extraterrestrials, astronauts, and a universe so vast that it can barely be imagined.

As more students and teachers became involved, the surer we were that space truly was a universal curriculum that touched on required skills at every grade level. Comparing mythology and sky legends from various countries, reading astronaut biographies, or analyzing science fiction stories in order to separate fact from fiction connects science to literature. Making a timeline of space technology or building scale models of the solar system integrates math and science. You will be surprised at the kind of connections that can be made when the universe is your subset.

Every module, from kindergarten through grade 12, is interdisciplinary...many science demonstrations and opportunities for graphing and calculating are combined with literature and social studies, with some singing and dancing thrown in. Many of the activities use a game or cooperative group format so that the students may choose from a variety of experiences having the same outcome.

Each Cosmic Classroom module builds on an understanding of basic concepts from the previous modules. The topics were selected to reflect a student's increasing abilities for abstraction and organization.

The six part series includes:

Module A
Living In Space
Grades K-2

Module B
Stars, Planets & Satellites
Grades 3-5

Module C
Moving In Space
Grades 4-8

Module D
Maps, Models & Measurement
Grades 7-10

Module E
A Space Presence: Life Sciences
Grades 9-12

Module F
A Space Presence: Physical Sciences
Grades 9-12

Space Center Houston would like to acknowledge the students and teachers who participated in the field test of these materials. The activities have been child-tested and approved for academic content and fun value.

Our thanks to the following teachers and their students:

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Thanks to the many scientists, engineers and astronauts at NASA's Johnson Space Center who checked the content for accuracy and a special thank you to Diane Kane and Jacqueline Martin, education specialists at SCH, and the Cosmic Classroom teachers.

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Content

Astronauts lose an average of 1% bone mass for every month spent in space. The bone loss is similar to that which occurs in people who undergo prolonged bed rest or lose the use of a limb due to injury or disease.

Older women are especially susceptible to bone loss and osteoporosis. To maintain density, bone growth relies on gravity. Muscles also rely on gravity, but for resistance, therefore, Shannon Lucid may have lost up to 25% of muscle strength in her legs. Recall that Lucid spent 188 days on the space station, Mir. Her muscles will have to relearn the signals from the nervous system. As a matter of fact, Soviet cosmonauts who returned to Earth in 1984 after 237 days in space experienced cerebellar atrophy. It took 45 days of Earth gravity before their muscle coordination allowed them to remaster simple children's games, for example.

On Earth, the risk factors determining osteoporosis are amongst the following: age, gender, race, bone structure, body weight, menopause/menstrual history, lifestyle, medications and disease, and family history. Once a person knows that she is at risk, steps in prevention can be taken.

Materials

Worksheet 1 (attached, p. 3-5 of 9)
Overhead A (attached, p. 6 of 9)
Overhead B (attached, p. 7 of 9)
Overhead C (attached, p. 8 of 9)
Overhead D (attached, p. 9 of 9)

See the electronic resources for more information on bone cell formation and loss.

Preparation

Review the skeletal system, the function of the human skeleton, the structure of bones, parts of the human skeleton, function of joints, and bone formation and growth.

Procedure - Example 1

- 1 Show Overhead A. Discuss with students the definition of osteoporosis and what the consequences would be of having porous bones would be. Discuss what

procedures could be responsible for this weakening of the bone.

- 2 Show Overhead B. Discuss the risk factors that determine osteoporosis.
- 3 As a class or individually, answer all four sections of worksheet 1. Discuss.

Procedure - Example 2

- 1 Discuss with students the risk factors that determine osteoporosis. Encourage students to identify the lack of weight-bearing exercise as a major risk factor for astronauts.
- 2 Discuss Overhead C and the NASA releases (found in the electronic resources section of references) which describe bone loss research and space flight.
- 3 Discuss how optimal nutrition is critical during space flight and how nutrition might play an important part in maintaining bone health during space flight. Discuss what the limited availability of fresh foods implies for bone health during long missions.
- 4 Show Overhead D. What sort of exercise programs would be effective in a micro-gravity environment?

Results

Assign students to 1 of 4 groups: each group will be assigned a subject for their unit report. Students (in groups) will complete a report on one of the following topics. Reports should include a complete description of the methods used to evaluate data.

A Adequacy of Adolescent Diets for Bone Health

Students should record food intake for 3 days (include amounts and preparation methods). Using food composition tables, calculate the amount of calcium and Vitamin D consumed each day.

Prepare summary data (means per student and per group) and include an evaluation of Vitamin D and calcium nutrition using the Recommended Dietary Allowances. Gender differences should be discussed, if applicable, and the significance of the findings should be included. See the Internet addresses provided in "references" to get started.

THEME

Human Effects

TOPIC

Skeletal System
Disease

METHOD

Small Group

TEKS

BIOLOGY:

Collects data and communicates valid conclusions

Analyzes and critiques scientific explanations

Interprets the functions of systems in the body

Analyzes the importance of nutrition, exercise, and environment on health

PREREQUISITE

None

See Teacher Aids at the end of this activity

ACTIVITY 2

Bone Health

B Bone Health During Space Flight

Using the Internet, students will review the most recent investigations into the effects of space flight on the bone health of astronauts.

C Bone Medicines

Students will conduct a research project to evaluate the usefulness of selected "health foods" in reducing osteoporosis. Prepare a weekly menu of foods that are rich in bone-producing ingredients. Using food composition tables, calculate the amount of calcium and Vitamin D consumed each day. Prepare summary data (means) and include an evaluation of Vitamin D and calcium nutrition using the Recommended Dietary Allowances.

D Osteoporosis

Students will review current therapies for osteoporosis and

References

report on osteoporosis incidence in men and women.
Books and Print Materials:

_____. NASA Facts: Food for Space Flight, available at regional Educators Resource Center. NF-133/6-82,

_____. "Space: A Fountain of Youth?" *Final Frontier*, Vol 10, pp 25-27. 1997.

Lebedev, Valentin. *Diary of a Cosmonaut: 211 Days in Space*. 1988.

Lerner, Preston. "Lifeboat". *Air and Space*, Vol 13(3), pp 72-78. 1998.

Lucid, Shannon W. "Six Months on Mir". *Scientific American*, Vol. 278(5), pages 46-55. 1998.

Thornton, William. "Splashdown". *Final Frontier*, Vol 11(3), p 64. 1998.

White, Ronald. "Weightlessness and the Human Body". *Scientific American*, Vol 279(3), pp 59-63. 1998.

Educational Videotapes:

All Systems Go. Liftoff to Learning Series. NASA Core # 006.3-11V

Assignment Spacelab. Liftoff to Learning Series. NASA Core #003.1-03V

The Musculoskeletal System in Space. NASA Core # 003.1-07V

Electronic Resources:

Bone Health

http://www.yahoo.com/Health/Diseases_and_Conditions/

Bone_Diseases/

Glossary and U.S. RDA Listing

<http://www.store.ripplecreek.com/glossary.html>

Indiana University Bio Archive

<http://iubio.bio.indiana.edu/>

Instructional Resources in Biology

<http://golgi.harvard.edu/biopages/edures.html>

Journal of Biology

http://www.educationindex.com/education_resources.html

Mission STS-77 Summary

<http://www.astro.space.gc.ca/sts77/S77SUME.htm>

NASA Homepage

http://www.nasa.gov/NASA_homepage.html/

NutrAnalysis

<http://www.nutranalysis.com/>

The Osteoporosis Center

<http://www.sonnet.com/usr/imaging/>

Space Shuttle

<http://www.ksc.nasa.gov/shuttle/missions/missions.html>

Spacelink-Life Sciences

<http://spacelink.nasa.gov/NASA.Projects/Human.Exploration.and.Development.of.Space/Life.Sciences/.index.html>

STS-69 Press Kit

<http://www.hq.nasa.gov/osf/shuttle/sts69/nih-4.html>

*Also, see list of references at the end of module.

Worksheet 1

Section A

Name the risk factors for osteoporosis. Circle those that can be controlled.

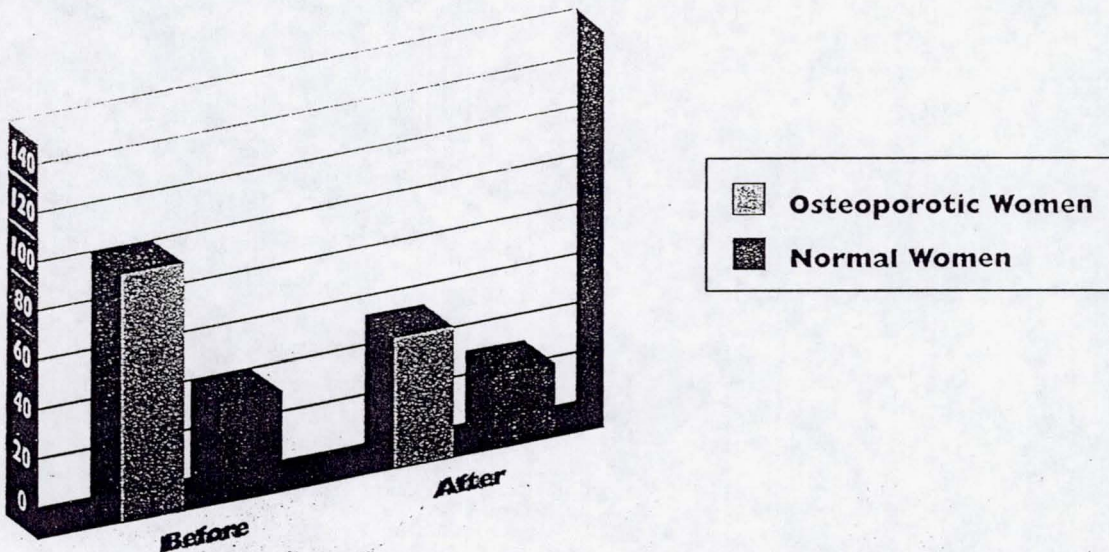
_____	_____
_____	_____
_____	_____
_____	_____

Section B

The effect of exercise on the excretion of a bone breakdown marker is indicated below.

The y-axis represents the marker concentration in urine.

The x-axis represents before and after the exercise.



Describe the significance of these findings.

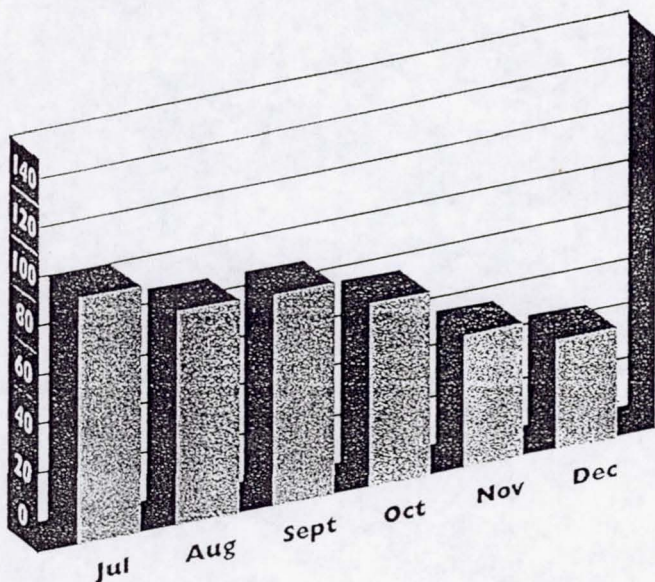
Compare the change in the marker in the osteoporotic women with that for the normal women.

Bone Health

Worksheet 1 Continued

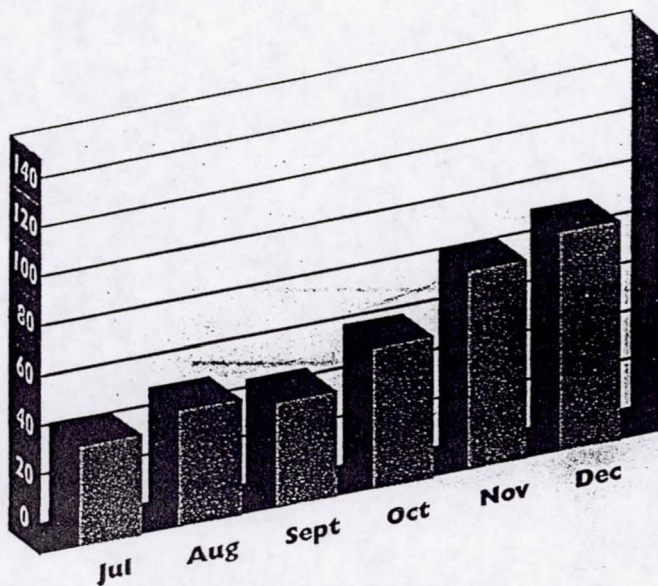
Section C

Changes in Vitamin D from July to December



Vitamin D

Changes in excretion of a bone breakdown marker from July to December



Marker

Worksheet 1 Continued

Describe what happens to Vitamin D over time.

Describe what happens to the breakdown marker over time.

What is the relationship between what happens to Vitamin D and the breakdown marker over time?

What is the change in both parameters from September to December for Vitamin D? Marker?

What is the significance of these findings for bone health?

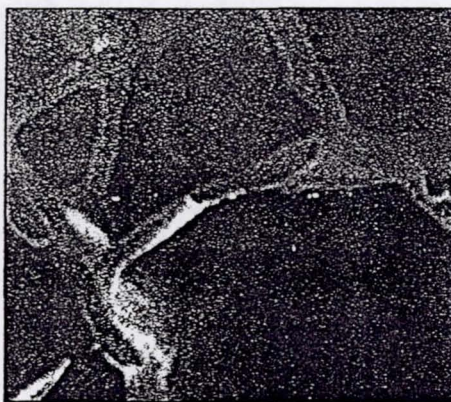
Section D

Describe in your own words the risk factors for bone loss in space flight.

Name at least 2 ways that these risks could be decreased.

What is Osteoporosis?

Osteoporosis is a disease in which bones become fragile and more likely to break. If left untreated, the disease will progress painlessly until a bone breaks. Of special concern are fractures of the hip or spine.



Osteoporotic Bone



Normal Bone

Risk Factors

- Age
- Gender
- Race
- Bone structure and body weight
- Menopause/Menstrual history
- Lifestyle
- Medications and disease
- Family history



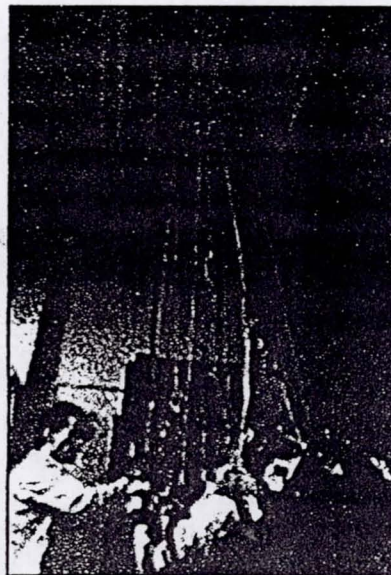
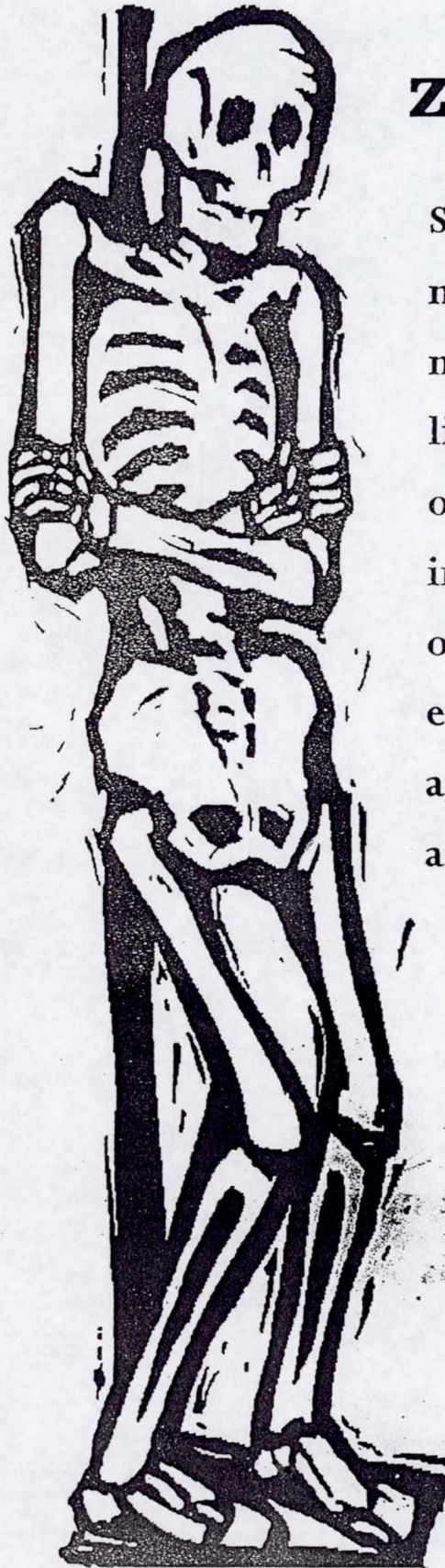
Space Risk to Bone Health



- Human bones slowly lose calcium (and other minerals in space)
- NASA data suggests that bone breakdown increases while formation is decreased
- Most of the bone lost is from weight bearing bones and lower back
- Minerals lost are transported by the blood to kidneys and increase risk of kidney stones
- Increased risk of fracture upon return from long missions

The Penn-State Zero-Gravity Simulator

Suspends subjects horizontally from multiple latex cords, with each cord negating the weight of different limb segments, a treadmill mounted on the wall enables subjects to run in simulated zero-gravity. The objective was to gain insight into the effectiveness of countermeasures against bone loss and muscular atrophy in space.



Content

A person's blood pressure is a measure of the force of the heart's contractions. The first number – the systolic pressure is the peak pressure at the moment the heart contracts and pumps blood into the arteries. The second value, the diastolic pressure is the lowest pressure in the arteries just before the next contraction.

The circulatory system is divided into 3 components: the heart, blood vessels and the blood. Its function is to act as a means of transportation by supplying the cells throughout the body with the substances they need to stay alive (for example – oxygen, and nutrients), and removing the waste products.

Head-down tilt bedrest is used as a model of some of the physiological changes of space flight. We will investigate how head-down tilt affects blood pressure and pulse rate.

Materials – Activity 1

Lab bench
Sphygmomanometer
Stopwatch
Pillows or blocks to elevate the feet
Inclined benches
Data sheets

Preparation – Activity 1

Teacher must know how to measure blood pressures. Plan to perform activity in the gym. Create angled benches by using plywood planks and blocks (4 or 5 students will need to lie down placing their heads below their hearts for 10 minutes). Alternately, exercise mats can be used to elevate the feet and place the head below the heart.

Discuss with students the following:

- A measure of the pressure produced by contractions of the heart and the muscle surrounding the heart is known as blood pressure.
- The heart, which is made up primarily of muscle, contracts at regular intervals, forcing blood through the circulatory system.

- The instrument that measures blood pressure is called a sphygmomanometer. It measures the pressure produced by the heart's contractions.
- Demonstrate how to use the sphygmomanometer correctly.
- Normal blood pressures: Systolic < 130 mmHg and Diastolic < 90 mmHg

Procedure – Activity 1

- 1 Students work in groups of 4-5, one student should be the subject in each group.
- 2 All group members should learn how to take blood pressures.
- 3 Record the subject's blood pressure using a sphygmomanometer. Repeat 3 times.
- 4 Record the subject's pulse rate (over 6 seconds) using a stopwatch. Multiply the number by 10 to obtain the number of beats per minute. Repeat 3 times.
- 5 Calculate the averages for each measurement.
- 6 Repeat steps 3 to 5 after the subject lies with feet elevated (and head below the heart) for 10 minutes. Use the data sheet provided to record your observations.

Cautions:

Make sure subject does not get nauseated easily. Support subject gently when bedrest study is completed. If subject feels faint, he should sit for a few minutes.

Results – Activity 1

How might head-down tilt bedrest be used to model some of the physiological effects of space flight? What other factors in space might contribute to high or low blood pressure?

Materials – Activity 2

Gamepieces or coins
Dice - one die for each team
Heart Quest Cards (see examples). These should be red, white, and blue to coordinate with the categories of questions as described below.
Heart Questions. Examples are given below. Teachers are encouraged to create additional questions as desired.

THEME

Interaction

TOPIC

Cardiovascular System

METHOD

Small Group

TEKS

BIOLOGY:

Conducts safe and ethical laboratory experiences

Plans and implements investigative procedures

Collects data and communicates valid conclusion

Interprets the functions of systems in organisms

Collects data and communicates valid conclusion

PREREQUISITE

None

See Teacher Aft at the end of this activity

ACTIVITY 7

Have A Heart

Procedure - Activity 2

This interactive game explores the circulatory system and discusses the effects of space flight. Students are assigned to 1 of 4 teams, and must answer questions from 3 categories: Cardiac Corner (CC), Vascular Valley (VV), and Blood By-way (BB). Questions are selected by rolling a die and moving along the Heart Quest Board. An appropriately colored Heart Quest Victory Card is to be given to each team for each correct answer provided: CC (white), VV (blue), and BB (red). Teams must collect a total of 9 Heart Quest Victory Cards, 3 from each category.

Results - Activity 2

The first team collecting 9 cards is the winner.

Procedure - Activity 2

Books and Print Materials:

_____. *The Brain in Space: A Teacher's Guide with Activities in Neuroscience*. NASA Life Sciences Division. EG-1998-03-118-HQ. Washington, D.C.

Educational Videos:

The Cardiovascular System in Space. NASA Core #003.1-06V

Electronic Resources:

NASA CD-ROM. *The Heart in Space*. NASA Core #400.0-80

Astronaut Training

<http://liftoff.msfc.nasa.gov/academy/astronauts/exercise.htm>

NASA Life Sciences Homepage

<http://www.hq.nasa.gov/office/olmsa/lifesci/tectrans/exercise.htm>

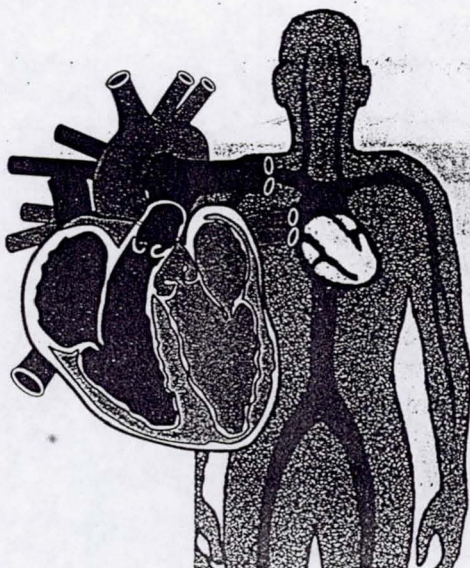
Neurolab Online

<http://quest.arc.nasa.gov/neuron>

Physiology in Space

<http://www.twinsisters.com/astronaut/activity2.htm>

*Also, see list of references at end of module



Have A Heart

HAVE A HEART worksheet for activity 1

BASELINE			BEDREST		
Trial #	Blood Pressure	Pulse Rate	Trial #	Blood Pressure	Pulse Rate
1			1		
2			2		
3			3		
Average			Average		

COMMENTS

ANALYSIS AND INTERPRETATIONS

What is the effect of head-down bedrest on pulse rate and blood pressure?

Explain these observations.

What are some of the implications of your observations during a real shuttle flight?

Have A Heart

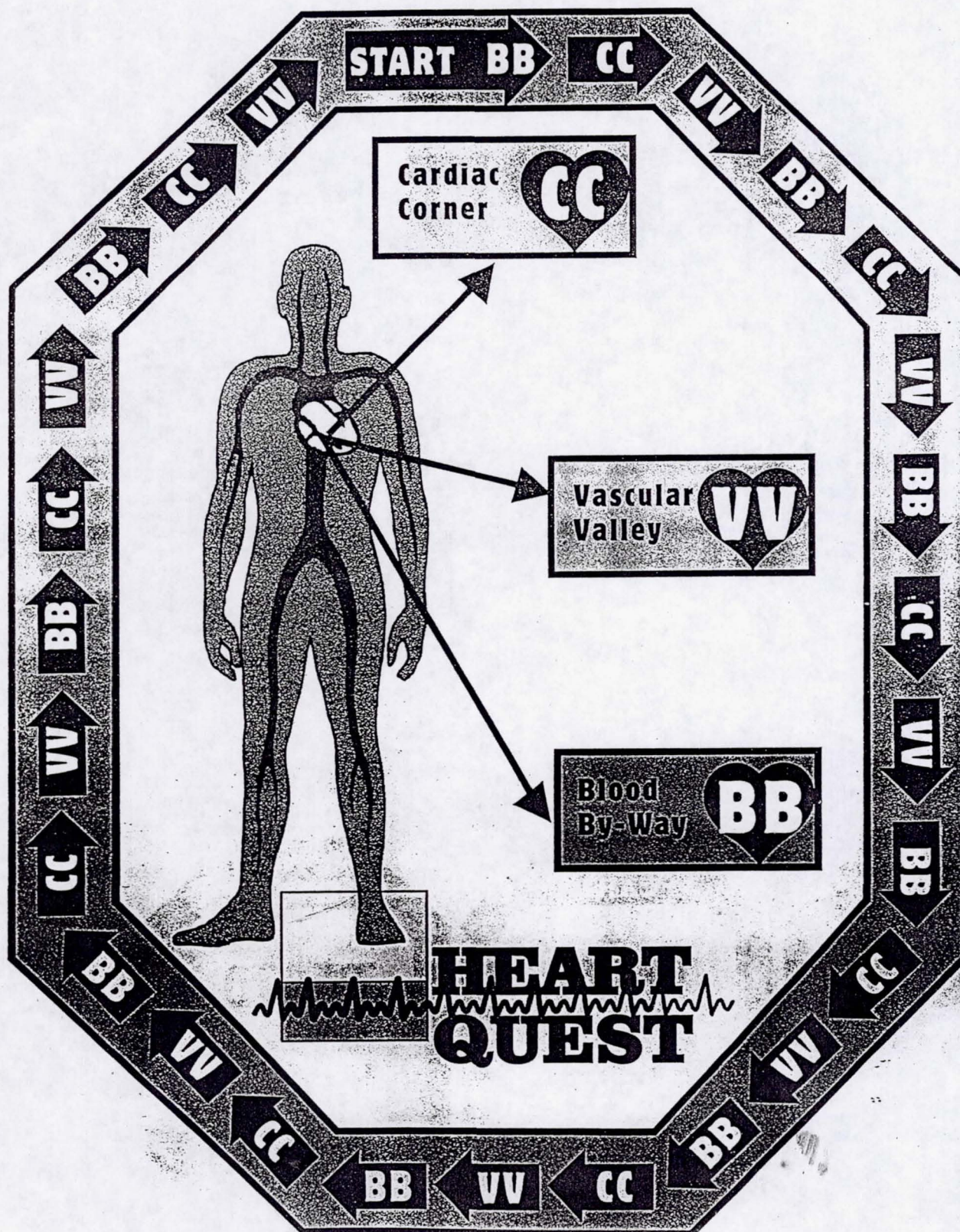
FACTS AND FIGURES

(Make into a transparency to review before playing Heart Quest.)

- The average heart beats about 100,000 times a day and some three billion times in the average lifetime.
- The heart typically moves about 9500 liters of blood in a day, and about 150-200 million liters of blood in an average lifetime.
- Cardiac muscle is supplied with more capillaries than any other tissue; it uses about 80% of the oxygen supplied by the blood compound, with about 25% used by most other tissues.
- When humans are in microgravity, blood and other fluids move from the heart and lower body into the head because their vascular systems no longer have to overcome the force of gravity to pump blood to the brain.
- During space flight, blood pools in the upper body and thorax. This condition is called a fluid shift.
- During space flight, the heart does not work as hard to keep blood flowing to the head, compared to being on the ground.

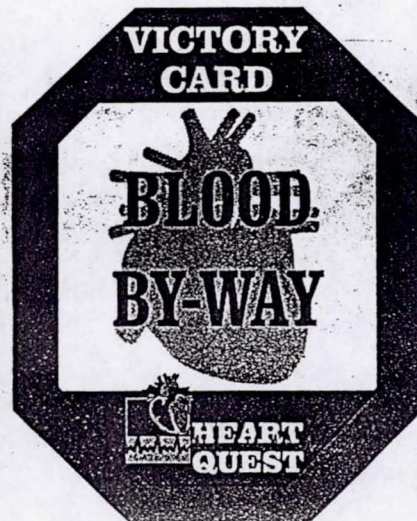
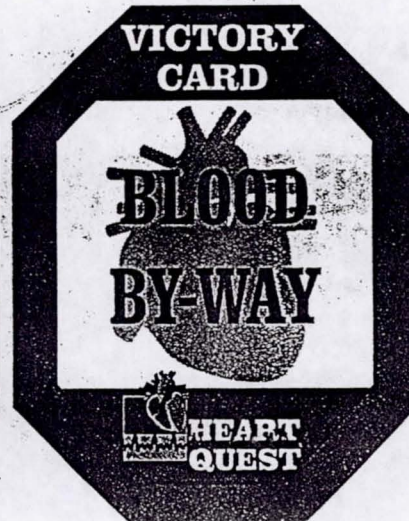
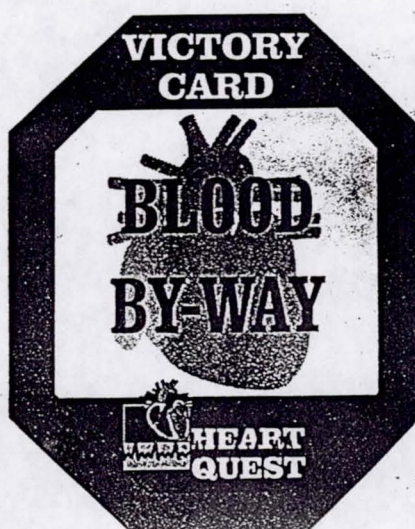
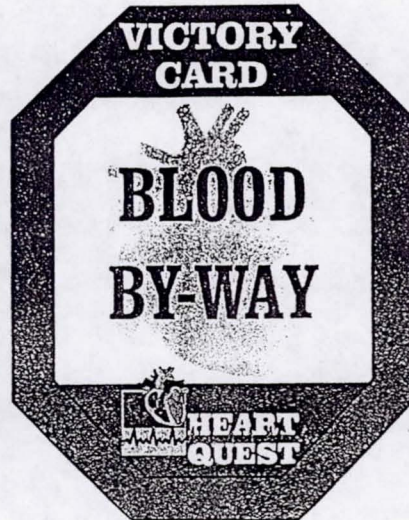
Have A Heart

HEART QUEST game board



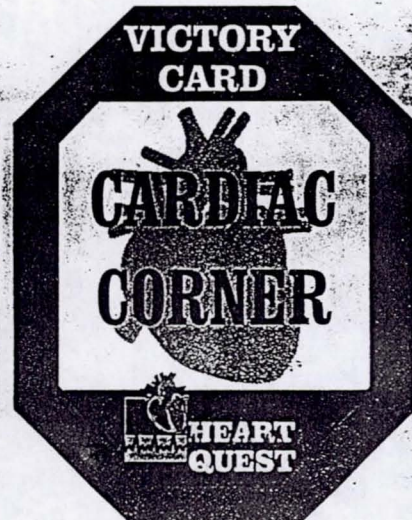
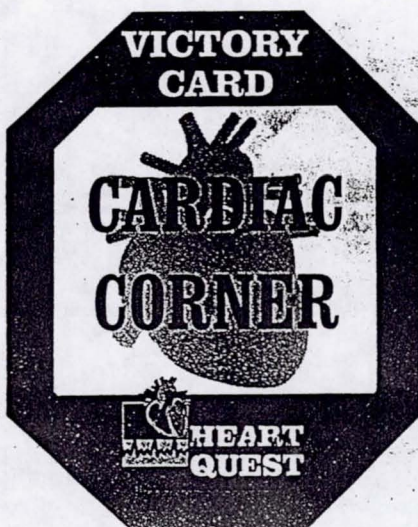
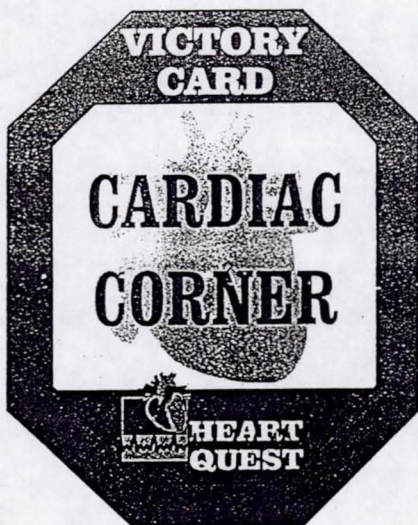
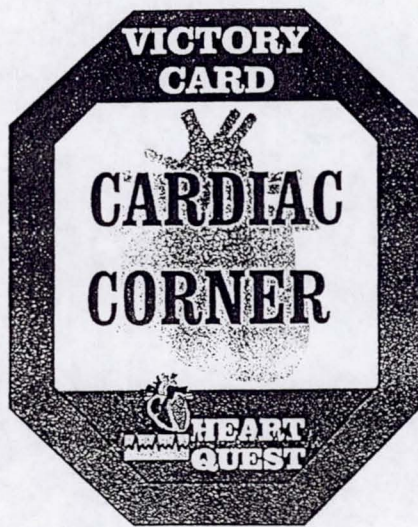
Have A Heart

Copy onto red paper.



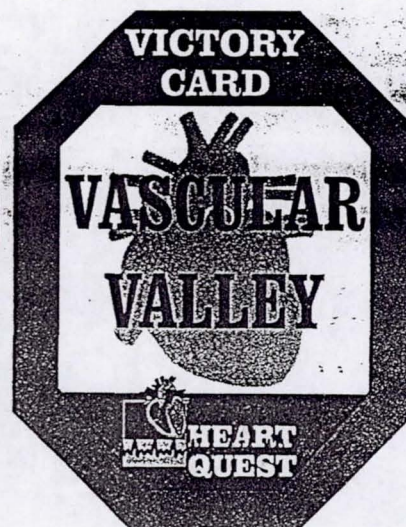
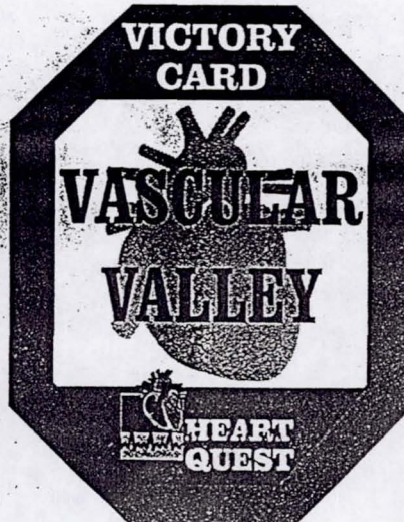
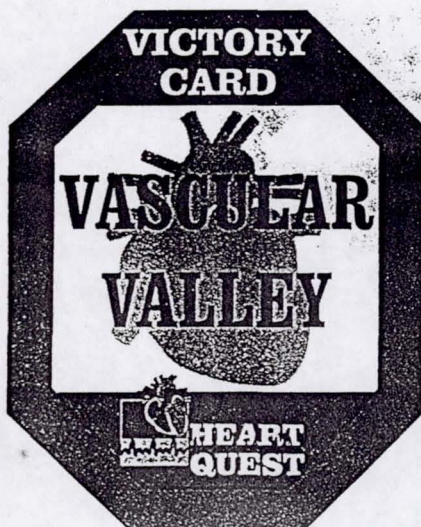
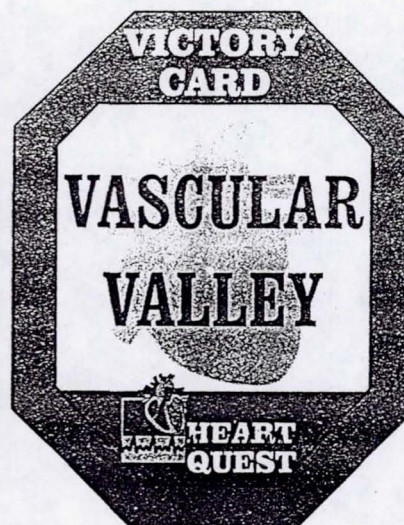
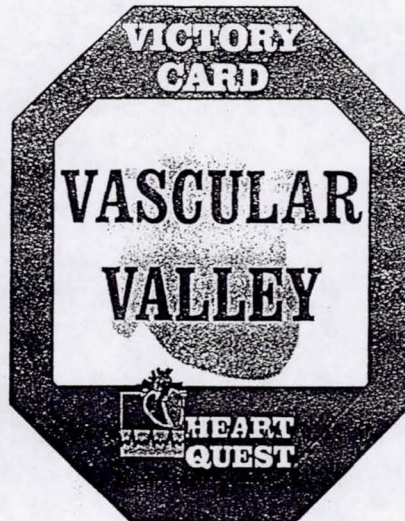
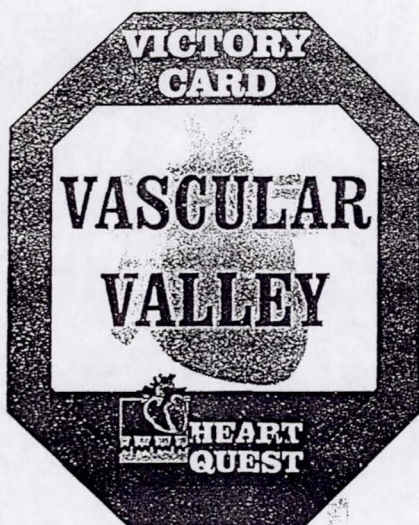
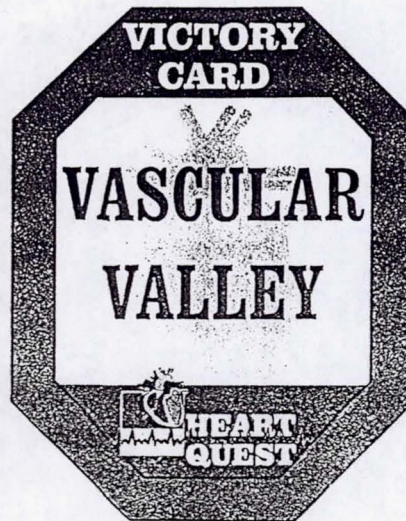
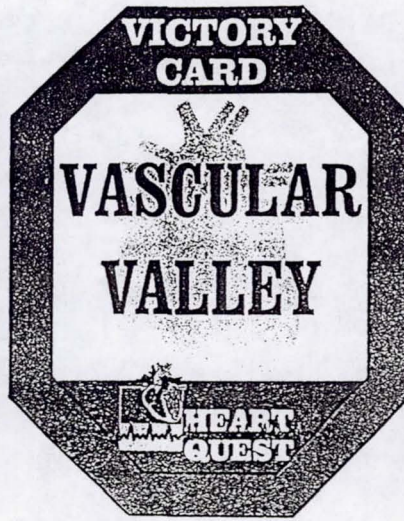
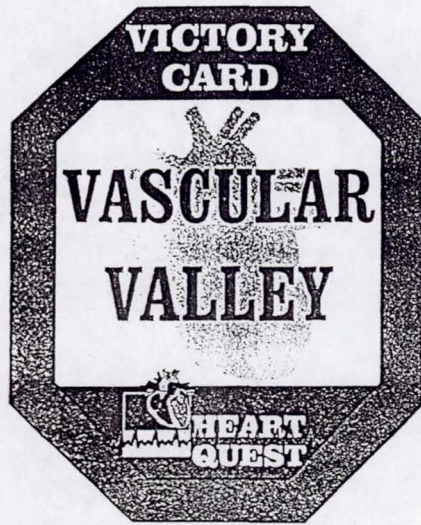
Have A Heart

Copy onto white paper.



Have A Heart

Copy onto blue paper.



Have A Heart

CARDIAC CORNER Questions

- What are the two chambers of the heart called? (The atrium and the ventricle)
- What is the upper chamber of the heart called? (The atrium)
- Which chamber pumps blood out of the heart? (The ventricle)
- What is the total number of chambers in the human heart? (Four)
- Each side of the heart pumps blood to different parts of the circulatory system. Where does the right side pump to? (From the heart to the lungs)
- Describe the processes which occur in the pulmonary circulation (Oxygen-poor blood is pumped by the right side of the heart through the lungs, [gives up carbon dioxide and picks up oxygen.] Oxygen rich blood is returned to the heart by the pulmonary veins.)
- What is systemic circulation? (Oxygen-rich blood leaves the heart and supplies the body with oxygen rich blood.)
- Why doesn't blood flow back from the ventricles into the atria? (The presence of valves ensures one-way flow.)
- What is the name of the muscular wall that divides the heart into two halves, preventing mixing of oxygen-rich and oxygen-poor blood? (The septum.)
- What effect does long-term space flight have on heart size? (It decreases.)
- True or false: Space flight may alter the heart rhythm. (True)
- What would happen as a result of the decrease in cardiac output in flight to an astronaut's ability to exercise post flight ? (It decreases.)

Have A Heart

VASCULAR VALLEY Questions

- What are the three types of blood vessels? (Arteries, veins and capillaries)
- Which blood vessels carry blood from the heart to the body? (Arteries)
- Which arteries do not carry oxygen-rich blood? (Pulmonary arteries)
- Which are the smallest blood vessels? (Capillaries)
- Where do the exchanges of nutrients and waste take place? (Capillaries)
- True or false: Veins have thin walls and are less muscular than arteries? (True)
- True or false: Capillaries contain only epithelial tissue and are one cell thick? (True)
- What role does smooth muscle play in arteries and veins? (It allows blood vessels to expand under pressure.)
- Why do capillaries not have a layer of smooth muscles? (To allow exchange of nutrients and waste)
- Which is greater cause for concern, increased systolic pressure or increased diastolic pressure? (Diastolic pressure)
- How does the body control blood pressure? (The autonomous nervous system and kidney)
- What is the largest artery? (Aorta)
- Why do some astronauts experience decreased blood pressure and faintness on return to the ground? (On re-entry into gravity the heart must work harder.)
- True or false: Blood volume is reduced during space flight? (True)

Have A Heart

BLOOD BY-WAY Questions

- True or false: About 50% of the body's mass is blood. (False – about 8%)
- What are the cells that make up the blood? (Red blood cells, white blood cells)
- What is the fluid part of the blood called? (Plasma)
- What are the three groups of proteins found in plasma? (Serum albumin, globulins, and fibrinogens)
- What is the role of serum albumin? (Regulation of osmotic pressure)
- What is the role of globulins? (They protect against infection.)
- What is the role of fibrinogens? (They regulate blood clotting.)
- Which cells are most numerous in blood? (Red blood cells)
- What is the role of the red blood cells? (They are oxygen carriers.)
- What component of red blood cells increases the ability of blood to carry oxygen? (Hemoglobin)
- Where are red blood cells produced? (In bone marrow)
- What is another name for white blood cells? (Leukocytes)
- True or false: Both white blood cells and red blood cells are produced in bone marrow. (True)
- Which live longer – red blood cells or white blood cells? (White blood cells)
- What is the main role of white blood cells? (To protect the body by guarding against infection, fighting parasites and attacking bacteria.)
- What is the role of platelets? (Blood clotting)
- True or false: White blood cells are increased after space flight. (True)
- True or False: Plasma volume is decreased after space flight. (True)

TEXAS AGRICULTURAL EXTENSION SERVICE

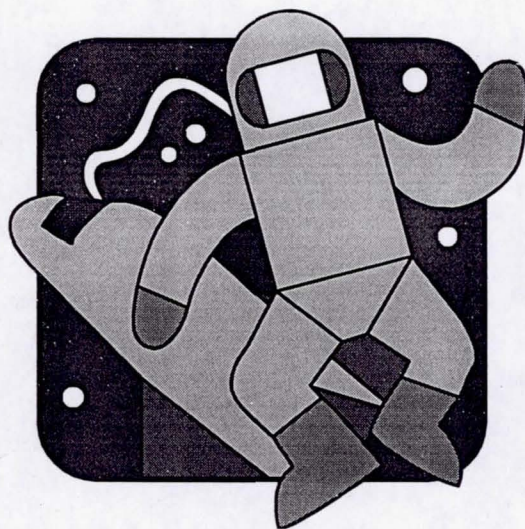
SOUTHEAST EXTENSION DISTRICT 9

4H LEADERSHIP LAB

NUTRITION IN SPACE

INSTRUCTIONAL GUIDE

JUNE 2000



BACKGROUND

4-H is a national youth leadership organization, whose mission is "to be an uncommon youth development organization fostering innovation and shared learning for youth workers and young leaders". We are excited to participate in this 2000 Summer Workshop, and to contribute to 4-H's goal of shared learning. The material enclosed in this workbook should allow workshop participants to use resource materials and handouts to conduct an annotated version of the workshop in their home institutions.

Goals

The goals of the current curriculum are as follows:

- Participants will understand the roles of food and nutrition during space flight
- Participants will be able design and/or select a nutritious menu for space flight
- Participants will be able to conduct a nutrition workshop at their resident institutions

This workshop is planned to be implemented as two 2-hour sessions. These sessions are described in detail below. Several of these sessions can be adapted and presented as shorter versions.

CONTENT

Nutrition in Space Workbook

Nutrition in Space Instructional Guide*

Handouts

Nutrition in Space Transparencies*

***Will be provided with materials to be mailed to Workshop Participants**

AM SESSION

A. Opening Activity (5 - 10 minutes)

Lunar/Mars Camping Trip - Resource: Lunar/Mars Camping Trip Handout. Participants list what foods/nutrients etc. they would need if they were planning for a trip into space (e.g. the Space Station or to Mars). Items should be written in the left-hand column. These items are reviewed, and edited if necessary, during the Closing Session.

B. Introduction: Nutrition in Space (45 - 50 minutes).

Slide Show describing the role of nutrition in human space flight - Resource: Slides.

Participants can follow along and make notes in the workbook provided. Black and white transparencies to support this activity are provided. The following is an outline of the presentation:

- Undernutrition
- Exercise
- Psychosocial Aspects
- Antioxidant Status
- Bones

"Calcium Counts" Activity. Resource - Calcium Counts Handout.

Participants recall what they had to eat for the previous 2 days, and record this information. This intake is scored using the "Calcium Counts" Scores. The purpose of this activity is to personalize calcium needs and to reinforce the importance of calcium containing foods in space and on Earth.

C. Film and Small Group Discussion (15 - 20 minutes)

Resource - "What's Cooking in Space, " (NASA video - provided.)

This film provides an overview of the role of food and nutrition on orbit. Narrated, by 2 astronauts, participants get a glimpse at life on orbit including issues like - waste management and psychosocial aspects of food and nutrition.

D. Food Preparation for Space Flight (30 minutes)

Slide show describing the freeze drying process, food safety and trash/waste disposal.

Resources - Slides

Participants can follow along and make notes in the workbook provided. Black and white transparencies to support this activity are provided. The following is an outline of the presentation:

- Slide Show - Food preparation
- Food Safety
- Trash and Waste Disposal

REVIEW/OPEN DISCUSSION

PM SESSION

A. Evaluating Space Foods (15 - 20 minutes)

Taste Test - Resources: Food samples, Containers, Taste Panel Evaluation Form

Objective: Participants determine the acceptability of food products for space flight by participating in a sensory taste panel.

Possible foods for evaluation - Use the food list provided for the Nutrition Challenge Activity. Many of these can be obtained from your grocery store.

Background

- Astronauts select their menu for space about 5 months before they fly. For the Space Shuttle, they select a menu that will serve them through the duration of their flight. For the ISS, they will choose a 30-day flight menu. These foods will be stored in the galley. A special taste panel is set up for the astronauts to taste a variety of foods when they are selecting their menus. This lets the astronauts know whether they like the food before going into space. Foods are tested for appearance, color, odor, flavor, and texture. It does not help astronauts to take foods into space if they will not eat them. This taste panel helps facilitate the selection of a desirable menu and reduces the amount of waste from unacceptable, uneaten, or partially eaten portions.
- Participants will rate these items using the numerical scores listed on the bottom of the form. If an item receives a score of 6 or less, comments can be listed to explain the low score. All other items can be described by their good qualities. Brainstorm a list of descriptive words that can be used.

Discussion Points (if several food items are evaluated)

- 1. Which space food would you prefer to take with you into space?
- 2. In each food type, which item received the highest score? Why?
- 3. In each food type, which item received the lowest score? Why?
- 4. Why do you think it is important that you test the foods before you take them into space?

Reference: www.spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Life.Science/Living.and.Working.in.Space/Space.Food.and.Nutrition/Classroom.Activity/ Select Activity# 2 - Food Selection

B. Nutrition Careers in the new Millennium (30 minutes)

Career Bingo and Slide show describing careers in dietetics and nutrition - Resources: Check It Out "Careers in Dietetics" video can be obtained from the American Dietetics Association, 216 West Jackson Blvd. Chicago, IL 60606-6995.

- Participants play the Career Bingo game, by filling out the bingo squares with numbers from 1-24. As the facts or images are mentioned or shown in the movie, use raisins or mark with an X on the corresponding number. The 'Check it Out Free Space' can be used to win diagonally, horizontally, or vertically. Additional slides describing other nutrition-related careers are presented. Participants can follow along and make notes in the workbook provided. Black and white transparencies to support this activity are provided.

C. Nutrition Challenge - Part A (40 - 45 minutes)

Resources - Food Lists, Scenario handouts, Food Guide Pyramid, Worksheets

Participants will be divided into 4 groups and given a nutrition-related problem to solve. Each scenario will describe a situation where creative solutions could be used. Participants will build upon the concepts and ideas provided during the day's session to provide a practical application of some of the issues facing space travelers of tomorrow. Part of this exercise will include designing a menu using 'space foods'. These menus are rated using the USDA Food Guide Pyramid.

Color codes can be used to divide students into groups as follows:

- Lunar Rendezvous - Blue
- Martian Menu - Red
- Space Station Surprise - Yellow
- Veggie Tales - Green

Background

The Food Guide Pyramid has been established to help people maintain a diet that is adequate in nutritional value. Maintaining good health in space is important, and to help do this, a good diet is imperative. Balanced meals of good nutritional food will help ensure that the astronauts will be able to perform their jobs in space.

The U.S. Department of Agriculture (USDA) has made recommendations for a healthy diet. Foods are grouped according to the nutrients they provide. Many foods, such as corn, are hard to place into a specific group. Sweet corn can be counted as a starchy vegetable, but corn tortillas are in the grain group. Dry beans and peas (legumes) can be counted as either a starchy vegetable or a meat.

Reference: www.spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Life.Science/Living.and.Working.in.Space/Space.Food.and.Nutrition/Classroom.Activity/ Select Activity# 4 - Classifying Space Food

D. Nutrition Challenge - Part B (15 minutes)

Participants will present group solutions and discuss common and contrasting factors associated with the various solutions. Use the Evaluation Form to summarize your findings.

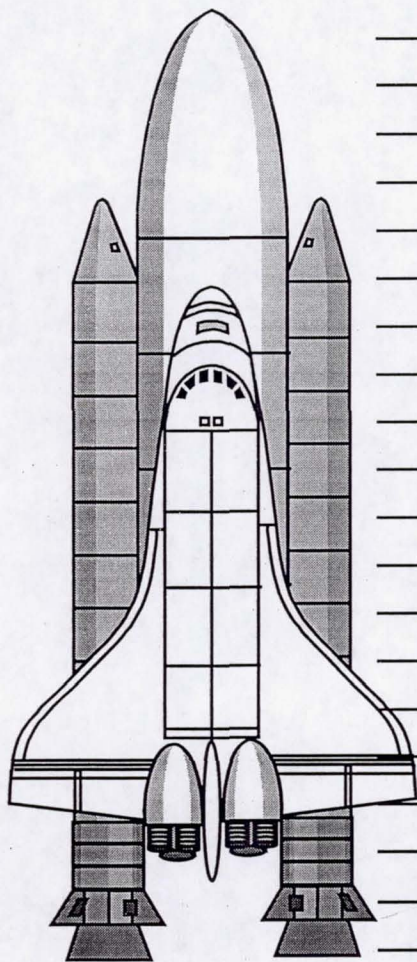
E. Closing activity (10 minutes)

Lunar/Mars Camping Trip - Using the handout from the morning's session, participants can modify their selections in the right hand column.

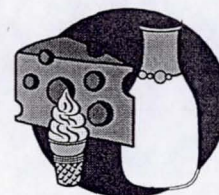
Name: _____

Lunar/Mars Camping Trip Handout

You are about to depart on a trip to the Lunar/Mars base. What factors should you consider? (Use as much detail as you can imagine).



Name: _____



Calcium Counts

STEP 1: Please indicate how often you ate the following items in the past 2-days- place a check mark for each occasion. Count the check marks for each group and multiply the total by counts below, and place in the column labeled 'Score'.

Food item	Frequency	Score
Group A Fruit Yogurt (1 cup) Calcium fortified cereal (1 oz.) with 1/2 cup milk Milk (1 cup) Orange juice and other juices with Calcium (1 cup)		
Group B Cheese (2 slices) Canned salmon (3 oz) Sardines (2 oz)		
Group C Plain cereal (1 oz.) with 1/2 cup milk		
Group D Ice cream (1/2 cup) Cottage cheese(1/2 cup) Frozen Yogurt (1/2 cup)		
Group E Broccoli (1/2 cup) Cooked Spinach (1/4 cup)		

Calcium Counts:

Group A - 300

Group B - 200

Group C - 150

Group D - 100

Group E - 50

Calcium - The Bone Builder



STEP 2: Add scores from each group, and divide by 2, to obtain the **TOTAL Calcium Count**. If your score is:

≥ 1200: Congrats! Your calcium intake is **Excellent**

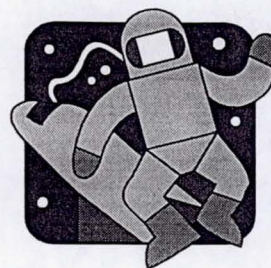
1000-1199: Your calcium intake is **Good**

800 - 999: Your calcium intake is **Fair**

< 800: Your calcium intake is **Poor**

Scores	
Group A	
Group B	
Group C	
Group D	
Group E	
Sub total	
Divide by 2	
TOTAL	

Name: _____



Taste Panel Evaluation Form

ITEM	SCORE
Color	
Odor	
Flavor	
Texture	
Overall	
COMMENTS	

High Scores:

- 9 - Like Extremely
- 8 - Like Very Much
- 7 - Like Moderately

Mid Scores:


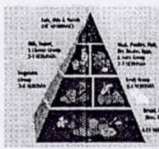

- 6 - Like Slightly
- 5 - Neither Like nor Dislike
- 4 - Dislike Slightly

Low Scores:

- 3 - Dislike Moderately
- 2 - Dislike Very Much
- 1 - Dislike Extremely

Nutrition Career Bingo

Just Check-It-Out!!

1. 	2. NASA makes sure that astronauts receive well-balanced and nutritious meals to stay healthy in space	3. RDs and DTRs may work with large companies, helping employees learn about optimal health, nutrition and wellness	4. Feast with the Beasts	5. Patients are treated by a whole team of health professionals, dietitians are the Nutrition Experts on that team
6. Travel through space presents special nutritional challenges	7. RD = Registered Dietitian	8. Nutrition professionals help people lead healthy lives	9. Dietitians in health care also conduct research on the effects of medicine and food on people's health	10. There are opportunities for dietetic careers in sports medicine,
11. Food Service nutritionists may be part of a team, working with doctors, nurses, social workers, RDs, DTRs, and chefs	12. RDs and DTRs can work in health clubs, high school, colleges and universities	Check-It-Out Free Space	13. www.eatright.com	14. Researchers investigate what food is made of, how it tastes, and whether it can be used in recipes
15. Dietetic professionals help people get and stay healthy by teaching them about food and nutrition	16. Dietitians help people learn how to eat well, so that they can live, work and play better	17. 	18. NASA scientists study how zero gravity and space travel affect the food and nutritional needs of astronauts	19. 
20. DTR = Dietetic Technician, Registered	21. Nutritionists can teach athletes how to incorporate specific nutritional strategies into their training program	22. Medical Nutrition Therapy	23. Nutrition professionals study food, nutrition, and science in college and they complete special on the job training	24. Dietitians can help individuals of all ages learn about the importance of nutrition and choosing healthy foods

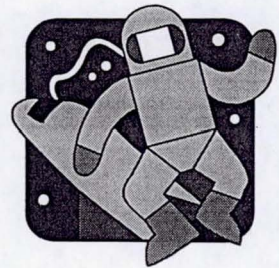
Nutrition Career Bingo

Just Check-It-Out!!

		Check-It-Out Free Space		

Directions: Please fill out these squares with numbers from 1-24. As the facts or images are mentioned or shown in the movie, place a raisin on the corresponding number. You may use your Check it Out Free Space to win diagonally, horizontally, or vertically. *Good Luck!*

Mission Scenarios



- Lunar Rendezvous

You are scheduled to depart for the Moon with your crew of 4 (2 males, 2 females), aged 25-35. Your mission stay will be 200 days.

Factor: Hardware

Why would you want to include the following hardware?

- Sun Lamp _____

- Treadmill _____

- Fresh Fruit/Vegetables _____

- Extra Dairy Products _____

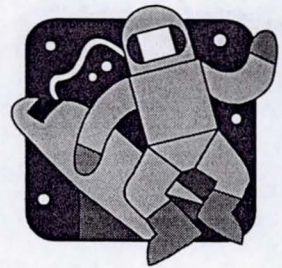
- Freezers/Refrigerators _____

- Food processing hardware/areas _____

Factor: Nutrition Requirements

Plan a Menu for typical day on the Lunar Base, and evaluate it using the Food Guide Pyramid (Use the Menu Analysis Grid and Space Food List).

Mission Scenarios



- **Martian Menu**

You are scheduled to depart for Mars with your crew of 4 (4 females), aged 40-50. Your mission stay will be 365 days.

Factor: Hardware

Why would you want to include the following hardware?

- Sun Lamp _____

- Treadmill _____

- Fresh Fruit/Vegetables _____

- Extra Dairy Products _____

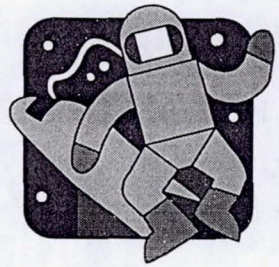
- Freezers/Refrigerators _____

- Food processing hardware/areas _____

Factor: Nutrition Requirements

Plan a Menu for typical day on the Martian Base, and evaluate it using the Food Guide Pyramid (Use the Menu Analysis Grid and Space Food List).

Mission Scenarios



- Space Station Surprise

You are scheduled to depart for the International Space Station with your crew of 4 (4 males), aged 40-50. Your mission stay will be 120 days.

Factor: Hardware

Why would you want to include the following hardware?

- Sun Lamp _____

- Treadmill _____

- Fresh Fruit/Vegetables _____

- Extra Dairy Products _____

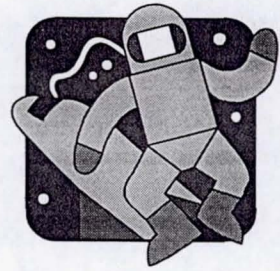
- Freezers/Refrigerators _____

- Food processing hardware/areas _____

Factor: Nutrition Requirements

Plan a Menu for typical day on ISS, and evaluate it using the Food Guide Pyramid (Use the Menu Analysis Grid and Space Food List).

Mission Scenarios



- Veggie Tales

You are scheduled to depart for a new space exploration mission with your crew of 4 (3 males, 1 female), aged 25-50. Your mission stay will be 600 days, and you will need to supply 50% of your food supply with vegetarian items (attached).

Factor: Hardware

Why would you want to include the following hardware?

- Sun Lamp _____

- Treadmill _____

- Fresh Fruit/Vegetables _____

- Extra Dairy Products _____

- Freezers/Refrigerators _____

- Food processing hardware/areas _____



Factor: Nutrition Requirements

Plan a Menu for typical day during your mission, and evaluate it using the Food Guide Pyramid (Use the Menu Analysis Grid and Space Food List).

FOOD GUIDE PYRAMID

Fats, Oil & Sweets
USE SPARINGLY

KEY

-  Fat (naturally occurring and added)
-  Sugars (added)

These symbols show fats and added sugars in foods.

Milk, Yogurt &
Cheese Group
3-4 SERVINGS

Meat, Poultry, Fish, Dry Beans,
Eggs & Nuts Group
2-3 SERVINGS

Vegetable Group
3-5 SERVINGS

Fruit Group
2-4 SERVINGS

Bread, Cereal,
Rice & Pasta
Group
6-11 SERVINGS

Milk Group

- 1 cup milk or yogurt
- 2 ounces processed cheese
- 1½ ounces natural cheese

Vegetable Group

- 1 cup raw leafy vegetables
- ½ cup cooked or chopped raw vegetables
- ¾ cup vegetable juice

Fruit Group

- 1 medium raw apple, banana or orange
- ½ cup berries
- ½ cup sliced, canned or cooked fruit
- ¾ cup fruit juice

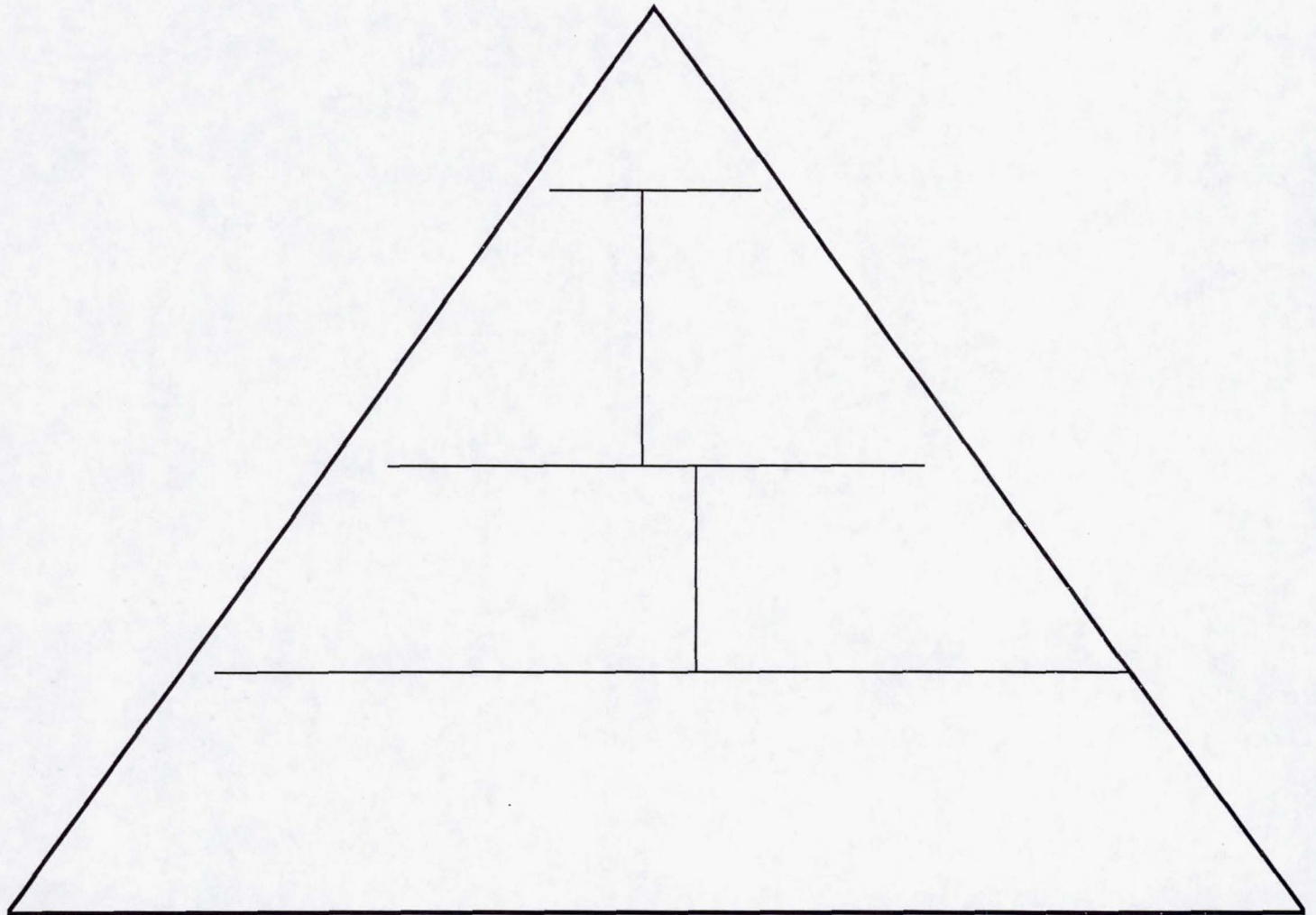
Meat Group

- 2 to 3 ounces cooked lean and low-fat meat, poultry or fish
- (1 ounce lean meat equals:
 - 1 egg
 - ½ cup cooked dry beans
 - ⅓ cup nuts or seeds
 - 2 tablespoons peanut butter)

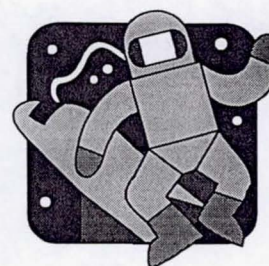
Bread/ Grains Group

- 1 slice bread
- 1 ounce ready-to-eat cereal
- ½ cup cooked cereal, rice or pasta

FOOD GUIDE PYRAMID MENU ANALYSIS GRID



Name: _____



Nutrition Challenge Summary Sheet

Scenario	Factors	Comments
	<ul style="list-style-type: none">●Sun Lamp●Treadmill●Fresh Fruit/Vegetables●Extra Dairy Products●Freezers/Refrigerators●Food processing hardware/areas	
	<ul style="list-style-type: none">●Sun Lamp●Treadmill●Fresh Fruit/Vegetables●Extra Dairy Products●Freezers/Refrigerators●Food processing hardware/areas	
	<ul style="list-style-type: none">●Sun Lamp●Treadmill●Fresh Fruit/Vegetables●Extra Dairy Products●Freezers/Refrigerators●Food processing hardware/areas	
	<ul style="list-style-type: none">●Sun Lamp●Treadmill●Fresh Fruit/Vegetables●Extra Dairy Products●Freezers/Refrigerators●Food processing hardware/areas	